THE

ELECTRICAL REVIEW.

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SUPERHEATING.

WITHOUT doubt, it appears that the pervading boom, to make use of an up-to-date colloquialism, in steam engine economy, is superheating. Barely a year ago Mr. Patchell's "Notes on Steam Superheating" was read and discussed at the Institution of Mechanical Engineers, while quite recently for two consecutive Tuesday evenings at the Institution of Civil Engineers, a paper on "Superheated Steam Engine Trials," by Prof. Ripper, was the subject under discussion.

The idea of superheated steam is by no means new, but steam engineers have been so busy in other directions, that the subject has been quietly shelved (at any rate in England), and remained in a more or less dormant condition for the last 30 or 40 years. During this period economies presenting less troublesome mechanical difficulties have been discovered and developed to their utmost extent. We have, within the last half century, witnessed a steady and persistent advance in favour of higher steam pressure. The losses in the cylinder due to excessive expansion have been very considerably diminished by adopting the use of more than one cylinder. Steam jacketing, invented by Watt, but abandoned by his immediate successors, has asserted and well sustained its economical value. The immense advantage of non-conducting coverings for reducing radiation losses has been clearly demonstrated, and their application is now universal in all cases where economy is studied. These and numerous other details, which may well be called refinements of the steam engine, have occupied the attention of many famous engineers and scientists of modern times. Although much more is theoretically possible in various directions, the practical limit seems to be almost reached, and what steps to take to further raise the standard of efficiency in the best steam engines of the present day is by no means an easy matter to decide. The use of superheated steam does, however, seem to be of growing importance, and steam users will do well to pay attention to the results of any experiments which have been made relating to it.

Steam is said to be superheated when it possesses a higher temperature than that corresponding to its saturation pressure. Superheating must not be thought of as a means of increasing the temperature range of an engine, but rather placed in the same category with steam jacketing. Theoretically, no important gain can be expected from superheating, but where the advantage of its practice comes in is, that the temperature of the cylinder walls is raised, and the losses due to liquefaction in the cylinders themselves can be reduced to a minimum.

The difficulty of procuring effective lubrication at such high temperatures has always been put forward as one of the most formidable practical drawbacks to the use of superheated steam, and with some reason, for great care is necessary in the selection of lubricants and packings to withstand a temperature of, perhaps, 600° F. Insufficient

lubrication leads to abrasion of valve faces, cylinder walls and piston rods; but, with the high class hydro-carbon lubricants and metallic packings now obtainable, there should be no insuperable difficulties (and recent experiments show that there are none) on this score.

With central station engineers, and no doubt with many others, the space at their disposal is very often an important consideration. Those in authority in more than one central station are at the present time considering the question of superheating, and wondering whether the balance is in its favour. The boilers and engines are already taxed to their fullest extent, and more power must be obtained by some means. The problem is one to which, for obvious reasons, it is impossible to give a general solution applicable to all cases, for the design and individual capacities of different sections of the plant must be taken into account before coming to a decision. This much can, however, be said in support of superheating, that in special cases it has been shown to effect almost 100 per cent. gain in combined boiler and engine power. But without hoping to come anywhere near this figure in the case of a plant of average efficiency when worked with saturated steam, it is not too much to anticipate a gain of 20 or even 30 per cent., say. If this additional power can be obtained by the introduction of superheating without any very great capital expenditure, and if at the same time the plant maintenance is not abnormally increased, then surely superheating is a good thing, and worthy of careful consideration.

A point which seems to be of special importance in the case of electric supply central stations is to have the superheater separate from the boiler, and arranged so that if it may at any time be necessary, the engines can be worked with saturated steam. The degree of superheat, and whether it is commercially economical to work with superheated steam right up to release, are problems which have yet to be solved. Every care should, however, be taken by the use of non-conducting materials to maintain the high degree of superheat right up to the cylinders. One of the easiest things to demonstrate by the introduction of a superheater is the badness of a boiler, and it is indubitably in cases where priming was plentiful that the most startling results have been arrived at by superheating. Finally, the commercial application of superheating is as yet in its early stage, but the difficulties to be overcome appear rather in detail than in principle.

ELECTRICAL CABS.

In the prospectus of the London Electrical Cab Company, dated November 12th, 1896, it was stated that the cells "are of special patented design, and suited to the variations of discharge which are at times necessary." From this one might reasonably assume that an accumulator had been secured which was likely to meet all the exigencies of London cab life. But at the statutory meeting held last Friday, a report of which appears in another part of this Journal, the chairman stated that tests were being made at Faraday House on accumulators placed on a vibrating board, so as to reproduce, as far as possible, the conditions of actual working.

This, no doubt, is an advance (?) on previous methods of testing cells for vehicles, but one cannot help thinking that the London Electrical Cab Company have not yet secured a cell in which they have complete confidence. We have already referred at considerable length to the various estimates put forward by the company and its engineers, and it is unnecessary to refer to them again; but we must draw serious attention to one or two statements made at the general meeting. It seems to us that the main essential in the use of electricity for self-contained vehicles is an accumulator, but it is obvious that the Electrical Cab Company, judging from their conduct, do not think so.

They pin their faith, apparently, to Mr. Bersey's system, but as no information is vouchsafed as to the features of this, it is impossible to say what grounds exist for their great belief. It may be fairly assumed, however, that accumulators form no part of the invention, for the company have entered into a contract with the E.P.S. Company for a supply of Faure-King cells. The Bersey system, therefore, may be said to comprise some form of gearing, and it must be an exceedingly valuable system, for practically £21,000 is being paid for it; moreover, it should not be forgotten that each cab is subject to a yearly royalty of £4. If we take the Electrical Cab Company's figure of 320 cabs, a royalty of £4 represents a capital value during the continuance of the patents of £17,920, or, in other words, the shareholders are paying the sum of £38,920 for a system which is not even described. We should not have been disposed to raise this point had it not been for the fact that the chairman mentioned, at the statutory meeting; that a valuable improvement had been made in the vehicle by the adoption of the Johnson-Lundell series parallel controller. This device is perfectly familiar to us, and we cordially agree with the chairman that it will prevent waste of electricity, and that it will "considerably simplify the construction of the vehicle by saving several complicated changes of speed gearings, &c., and by saving these and the necessary handles, it will make the driving of the vehicle much easier." It has proved to be a most effective apparatus on electric tramways, and is probably worth the royalty which the Electrical Cab Company propose to pay to the British Thomson-Houston Company. But the question naturally arises, How much of the Bersey system of gearing, for which £21,000, and £4 per cab per annum is charged, will be superseded by the Series-Parallel controller? It seems to us that if it is properly applied most of the gearing is done away with, and the company, by adopting a form of controller, sweep away the main features of a system for which they are paying so heavily.

3¾d. per Unit.

It would be difficult to over-estimate the importance of the report, published on another page, which Mr. Wright, the borough electrical engineer of Brighton, has submitted to the Corporation. If the Town Council sanction the suggested change of tariff, and it is not likely that they will do otherwise, Brighton consumers will be in the enviable position of obtaining electricity, after the first hour of daily use, at the rate of 1½d. per unit, or put in another way, the probable average price paid for electricity in Brighton this year will be about 3¾d. per unit. Without going into a general consideration of the Wright system in all its bearings, there is little doubt that it forms one of the most valuable methods of charging for electricity, and central station men owe much to Mr. Wright for the scientific and practical manner in which he has worked out a method that benefits the rich and poor consumer alike, nor should the efforts of Dr. John Hopkinson, probably the first to suggest such a mode of charging, be forgotten. The acceptance of the principle by some 30 towns leads one to be hopeful of a general lowering in price.

MR. STURGEON AGAIN.

We have before now had occasion to pour a little wholesome ridicule upon the "irrepressible Mr. Sturgeon," as he is sometimes called. We refer to the gentleman who spends his time in writing from Leeds to the local papers of every town or district where there is any talk of installing or equipping an electric tramway, throwing all the mud that he can rake together upon the subject of electric traction, and praising with the most one-sided adulation the methods of cable traction.

As a solitary prophet in a desolate wilderness, Mr. Sturgeon stands or forces himself prominently forward; but no one who has in any way studied traction systems, or knows the least little bit of electric and cable working, would pay a moment's attention to the efforts he makes in this way to advance his pet theories, the usual remark being to the effect that Mr. Sturgeon may very well be left to himself to learn wisdom, like Sydney Smith's worthy old dame, who tried to mop up the Atlantic. But Mr. Sturgeon sometimes goes a little too far, and comes in then for a tremendous smashing from some irate engineer whose statements and figures he apparently cuts and carves to suit his own purpose, and if it were possible to impress him permanently, he would long ago have seen the error of his ways.

The reason for our dealing with this gentleman again is that he has been addressing some remarks to the Belfast *News-Letter*, with the apparent object of arousing opposition in that city to the otherwise unanimous desire of practically the entire population for electric tramways, whenever an agreement can be effected between the Corporation and the tramway company. Mr. Sturgeon's letter deals entirely with matters and figures given in the last report of the Glasgow Corporation Tramways manager and engineer; and a more unfair or illogical tissue of misrepresentation it has seldom been our disagreeable duty to read. The fairness of a confessed partisan in regard to cable traction is shown in the calm statement that an abstract from his particular point of view gives the *essential* parts of the report! In his letter, Mr. Sturgeon of course intends to show, and aims at showing, that the result of such facts and figures as were obtained by, or given to the Glasgow manager and engineer, prove beyond all doubt, to the fair and unprejudiced mind, that electric traction is of absolutely no use at all for city work. *Why, then, did Messrs. Young & Clark* (the two Glasgow gentlemen) *conclude their report with the strongest possible recommendation that the electric trolley wire system should be adopted without the least hesitation?*

Obviously that can only be due to one of three reasons. In the first place, they must have been quite inept, and unable to draw proper conclusions from the particulars before them; that they were, in fact, quite incapable, and arrived at a conclusion wholly unwarranted by the premises. In reply to such a suggestion, we can only say that Glasgow is not likely to appoint, or to keep in position, a couple of incompetent men—and we say this on the assumption that Messrs. Young & Clark are absolute strangers to us. As a matter of fact, we know them to be fully as competent as Mr. Sturgeon, and much more experienced in general traction methods.

In the second place, Messrs. Young & Clark must, as an alternative, have some personal interest in advocating electric traction, when (according to Mr. Sturgeon's views) it is shown to be worthless by the actual facts from America. This is rather a serious alternative for Mr. Sturgeon to adopt; and to suggest that these gentlemen have practically been asked to recommend the trolley wire, is, to say the least of it, not "good manners," yet they must have had *a* reason for this recommendation, and we propose to let Mr. Sturgeon choose which he will have of the possible reasons. If he likes this one, doubtless Messrs. Young & Clark will know how to deal with him.

In the third place, it might be considered that these gentlemen came to the conclusion that they did from an honest and unprejudiced examination of all the facts: and we leave the common sense of our readers to decide as to which of these three reasons actually came into operation; also whether Mr. Sturgeon or Messrs. Young & Clark drew erroneous deductions.

Mr. Sturgeon may write as many screeds as he pleases, and knock his head against a stone wall for the rest of his life if he desires; but let him do the first fairly and in good above-board manly British fashion. A letter to the papers is often like a stab in the back; thousands read it who never see a reply, and consequently the first is taken as gospel by the ignorant. Those interested in electric traction never trouble to speak ill of cable traction, but are sensible enough to admit its great usefulness under conditions. Let Mr. Sturgeon at least do the same on his side, and not make himself ridiculous by denying the possibility of electric traction ever being reliable, safe, or economical. It may interest him to know that the largest cable tramway interests in this country (and we will mention names, as it is a matter of public knowledge)—such as Messrs. Dick, Kerr & Co., and if we mistake not, Messrs. Geo. Cradock & Co.—have for some time realised the importance of electric traction, and are actually interested in its development alongside cable working, in some cases in combination with it.

BRAKES FOR ELECTRIC MOTOR CARS.

Mr. M. K. Bowen, the well-known superintendent of the Chicago City Railway Company has recently supplied the *Electrical Journal* of the same place with some interesting particulars of a powerful friction brake which his company has adopted for their electric cars after trials extending over two years under all conditions of working.

The necessity for a more powerful brake than those used with the old type of light horse car is obvious to anyone who cares to calculate the respective momentums of such a car and of an 8 ton electric car running at an average speed half as great again; the ratio between the two will range as high as 1 to 7, and it is, therefore, ridiculous to expect that the motorman will either be able or willing to use his brake in the proper manner, putting it on hard at first and gradually decreasing the pressure as the speed is reduced. Friction power brakes are, of course, well known both in tramway and railway work, amongst the best of such being without doubt the Heberlein, acting from the friction between a fixed disc on the car axle and a similar disc running in bearings in a pivoted lever; in nearly all these devices the loose disc serves to wind up a chain attached through rods and levers to the brake shoes.

There are, however, many ways in which the friction mechanism can be arranged, and the method adopted at Chicago is claimed to be particularly designed for use with electric motor cars on account of the small space required on the car axle. As a rule, one can only depend upon securing 3 or 4 inches of spare room between the collar for motor bearing and the inner side of car wheel: and it is in this space that any mechanism for braking the car is to be placed. Essentially the Chicago device consists of an annular disc of cast-iron running upon a steel sleeve forced on the axle by hydraulic pressure; the disc bears—through a stout leather ring or washer—upon the inner side of the car wheel, being driven round by the latter when brought into contact with it by sliding endways upon the sleeve. This end motion of the disc is effected by a very neat and ingenious form of friction clutch in which a screw operated by the platform brake lever is made to separate the outer ends of two hinged levers, and thus force the disc into contact with the car wheel, thereby winding up the brake chain and putting a force on to the brake shoes in strict accordance with the car speed.

The brakes upon trail cars are operated by this method quite easily, the chain pull being transmitted through equaliser and other rods with great ease and safety.

It seems to us that devices of this kind are most essential for the proper working of electric tramways.

Without them, there is not only the constant danger of accident through the higher speeds resulting from the use of electric traction, but the motorman also finds himself obliged to do one of two things: first, strain his body and muscles to an unnatural extent every time the car is stopped; or, secondly, consider himself of more value than the car, and, therefore, leaves the break hard on, irrespective of slipping wheels with their attendant "flats" and bumpy motion.

D

It doesn't take much acumen to decide as to what is likely to be the ultimate result; so that in view of the increasing use of electric traction in this country, we advise all concerned to "remember the brakes," and not to be content with what has hitherto served for quite different conditions.

OBSERVATIONS ON MAGNETISED WATCHES.*

BY WILLIAM T. LEWIS, Member of the Institute, President of the Horological Society of Philadelphia.

(*Concluded from page* 156.)

With the ordinary demagnetiser the hair-spring of a watch is very difficult (if not impossible) to demagnetise without treating it separately, as it possesses about four times as many magnetic poles as it contains coils. The poles are difficult to locate, as the coils are not more than 0·15 millimetres to 0·25 millimetres apart in watches of the usual size. The whole diameter of the spring may be from 5 millimetres to 8 millimetres.

Then, also, the vibration of the hair-spring under the action of the demagnetiser seems to prevent the proper demagnetising effect from being produced.

Good results, however, can be secured by placing the hair-spring on a watch-glass and covering it with very viscous oil or with a drop of melted beeswax, and placing it in that condition under the action of the demagnetiser, keeping the watch-glass horizontal and, at the same time, causing it to revolve about its centre. The oil or wax can afterwards be dissolved in benzine and the hair-spring cleaned.

Demagnetisers of various construction have been contrived; but I do not know of any which will *thoroughly* demagnetise all the parts of a watch *unless the watch be taken apart* and each steel piece submitted separately to the action of the demagnetiser, testing each piece each time it is passed through the machine in order to ascertain to what extent the magnetism has been removed, and again passing it through the helix in another position if it be found to still contain magnetism.

If, in passing the watch through the helix (without taking it apart), any steel part be so situated in the watch, and be also magnetised in such a manner that its magnetic axis be *otherwise* than parallel to the axis of the helix, it will be seen that such part will not be thoroughly demagnetised.

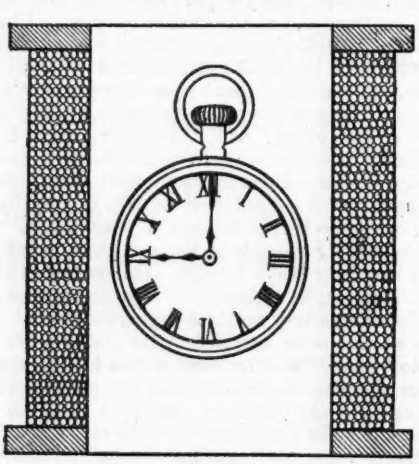


FIG. 6.

Fig. 6 shows a view of the helix, in section. The hands of the watch denote the hour of 9 o'clock. If, before the watch was passed through the demagnetiser, one end of the minute-hand was a north-seeking pole, and the other end a south-seeking pole, it is evident that the minute-hand will now be demagnetised.

But to demagnetise the hour-hand, the watch would need to be turned so that the magnetic axis of the hour-hand would be parallel to the axis of the helix. There is also the steel arbor which carries the hands, the axis of which is at right angles to the planes in which the hands lie. Then there are other steel parts which lie in other planes; so that it would seem necessary to cause the watch to revolve in such a manner that every plane shall be subsequently brought into a position parallel to the axis of the helix.

To this end I am now constructing a demagnetiser, which I may have the opportunity of exhibiting at some future meeting; but which I will now describe in order that I may have the advice of others better versed in the mysteries of electricity and magnetism than myself.

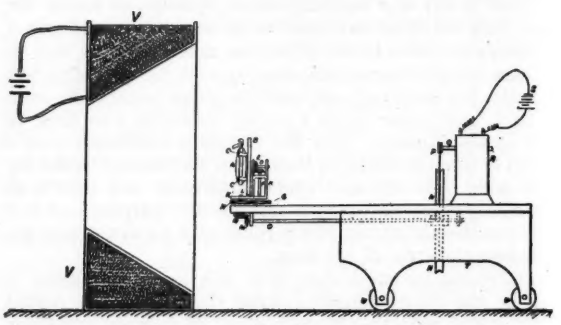


FIG. 7.

In fig. 7, A is a watch to be demagnetised, mounted on a circular disc, B, being held in position by the clutches, C C, and a third clutch which is not shown. The disc is caused to revolve by the bevel gears, E E′, which receive their motive power from the gear, G. The gear, H, is stationary; while the frame, K K′, is mounted on the revolving shaft, L, driven by the bevel gear, M M′, which in turn is caused to revolve by a belt from a pulley, N, on the shaft, O, to the

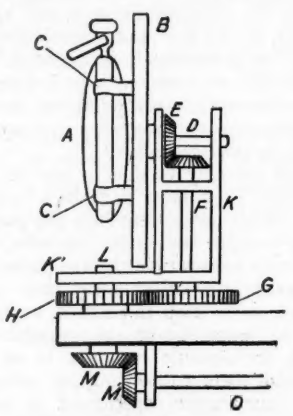


FIG. 8.

pulley, P, on the shaft, Q, of the small motor, R, which is driven by the battery, S. This motor will be enclosed in an iron cylinder to insulate it magnetically, and so prevent its influence on the watch. A clock-work could, of course, be used instead of the motor. The head of the carriage is shown separately in fig. 8.

It will be seen that the revolving of the frame, K K′, around the axis of the shaft, L, will cause the gear, G, to revolve around the gear, H. At the same time the revolving of the gear, G, on its own axis will cause the disc, B, to revolve around its own centre.

Thus the watch will revolve around its vertical axis (*i.e.*, the axis of the shaft, L) and around its horizontal axis (the axis of the shaft, D) at the same time. By having one tooth more (or less) in the gear, G, than in the gear, H, the watch will be continually placed in new and different positions, until the gears, G and H, arrive in the same relative positions in which they were at the start.

* *Franklin Institute Journal.* Read at the stated meeting of the Franklin Institute, November 18th, 1896.

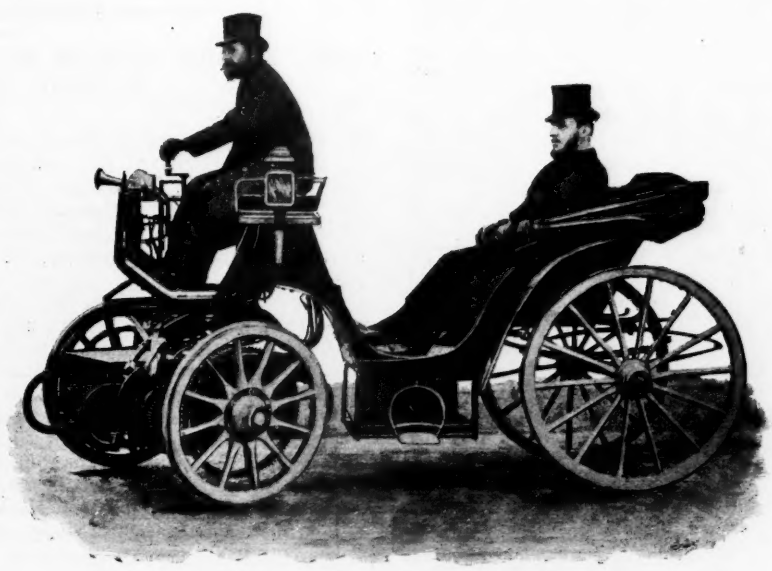
The carriage, 7, is mounted on wheels, U U′, in order that the watch may be slowly advanced into the helix, V, to its smaller end, and again slowly withdrawn. It should be withdrawn to a distance of several feet from the helix.

The helix, as shown in section, is given this form in order that the electro-magnetic effect of the current on the watch may be gradually increased and diminished as the watch is advanced into the helix and withdrawn. When the watch has reached the smaller end of the helix there are more lines of magnetism passing through it for the reason that there are more coils of wire around and about it, and the coils are also nearer to it. Thus the polarity of each steel part of the watch is successively changed with a gradually diminishing force as the watch is slowly withdrawn, until every piece of steel in it is brought back to its normal condition. Such is my theory, and I hope my machine will be successful. In the meantime I will be glad to receive any suggestions.

THE "KRIEGER" ELECTRIC CAR.

Are we to have the "automobile" cab yet? We hear it talked of on all sides, its advent is announced every day, but like Sister Anne, it does not appear. It would, however, be in universal request if it worked without noise, without smell, and without smoke; to fulfil these conditions, it must be electric.

The Americans are in advance of us (says A. T., in *L'Energie Electrique*), according to a letter from New York, which informs us that a motor car company put on the road, on the Russian New Year's Day, several compressed air cabs. In Paris, M. L. Krieger has promised us for the summer the electric cab, and at the last sitting of the *Société des Electriciens* he gave a description of it accompanied by drawings.



Old Carriage.

This, constructed from an old carriage adapted to the purpose, has worked in Paris. The tractor acts upon the axle of the fore-part of the carriage. This axle is rigid and has a wheel at each end. An electromotor acts on each of these wheels. Each motor has, on the axle of the armature, a pinion with a helicoidal system of teeth catching in a wheel toothed in the same way fixed directly on the corresponding motive wheel. The ratio of the gearings is as 1 to 10. Each motor is centred on the axle by its breech-pin and suspended by a pole-piece to a spring in such a manner that oscillating round the point of suspension taken on the axle, the distance of the centres of the toothed wheels does not vary. The employment of a high ratio for the gearings enables a sufficient angular speed to be given to the motors to attain, with a reduced weight, to an efficiency sufficiently high to make the working economical. In the motor the weight and the mechanism are greatly reduced owing to the form of the field-magnets, all framework for the motor being rendered unnecessary and to the ring winding of the armature with fixed teeth; a single bearing fixed on the field-magnet by three screws has been adopted. The motor has been designed by Messrs. Krieger and Rechniewski, and constructed by the Postel-Vinay Company.

The direction of the cab can be effected in three different ways. The fore-part of the cab turns at an angle equal to that at which the handle turns. The first carriage, constructed from an old vehicle belonging to the "Abeille" Company, weighing altogether 1,150 kg., has performed journeys of 30 kilometres. In this weight is included a battery of "Fulmen" accumulators of 285 kg. M. Krieger rightly makes a point of the unsuitability of this carriage for the purpose, it having been made 10 years ago, and the fore-part not being calculated to bear such strains.

A second cab, specially constructed for electric traction, is much heavier, 1,800 kg. when empty. The fore-part weighs 1,630 kg., but a journey of 80 kilometres can be performed without recharging the battery and of 60 kilometres with gradients like that in the Rue Renouard, where the output amounted to 185 amperes at 30 volts.

This battery, which is specially adapted for this purpose by M. H. Meynier, the commercial agent for the Julien accumulators, has a capacity of 450 ampere-hours and a total weight of 640 kg. It comprises 16 elements, each consisting of 33 kg. of electrodes.

Each element is contained in an ebonite trough with three compartments. This arrangement, which is equivalent to three elements connected in parallel, has the advantage of keeping the plates in position, and particularly of more effectually localising an accident to any plate.

Each cell contains 13 plates 6½ mm. thick, or 39 plates per element. The capacity being 450 ampere-hours, we get about 15 ampere-hours per kg. of plates. The ebonite troughs are protected by cases of thin oak. A layer of a special kind of gum is then run over the surface of the liquid of each element.

When this composition is dry, it serves the purpose of a thin layer of slate, being both air-tight and water-tight, and thus capable of resisting shaking, which is the most formidable obstacle encountered by accumulators on a journey.

Two motors of 150 kg. turning at the angular speed of 600 revolutions per minute give a maximum motive couple of 13 kgm., the normal couple being 1·5 kgm. The *regime* of discharge of the accumulators is from 50 to 60 amperes at 30 volts for progress on level ground, with a mean speed of 10 to 12 km. per hour, even with the hills on the road from St. Cloud to Garches.

An accident to the plate, showing a representation of this second cab, deprives us of the pleasure of placing it before our readers. The photograph of it had been taken when on a journey with its five passengers, among which was an eminent electrician.

With five passengers the cab performed a journey of 65 km. without stopping, at the mean speed of 11 km. an hour. Altogether, this cab has already travelled 2,500 km. within Paris at a mean speed of 10 km. an hour.

M. Krieger has promised us soon the ordinary coupé with two seats and driver's perch capable of travelling 125 kilometres without recharge. This cab will only weigh 800 kg altogether, the new accumulators, for which a single charge at night will be sufficient, weighing 350 kg. M. Krieger has not given us the name of this ideal accumulator. The price of the kilowatt-hour of electrical energy being very high in Paris, it is expedient to suppress as far as possible

frequent chargings and dead weight, even to the detriment of the accumulators, the latter being less expensive than Parisian electrical energy.

COMPETITIVE SYSTEMS OF TRACTION IN NEW YORK CITY.*

There is probably no city in the world where so good an opportunity is presented for a comparative test of the merits of the various systems of street traction as that which is offered on the lines of the Metropolitan Traction Company, New York. In addition to its world-renowned Broadway cable line, which carries by far the heaviest traffic of any cable road in existence, the company operates some miles of electric underground trolley road on Lennox Avenue, upon which also it is running experimentally some compressed air motors built on the Hoadley patents. The fierce competition between the surface and elevated roads of the city is favourable to an unbiassed judgment of results; for it is safe to say that after complying with the restrictions of the law, that system which proves to be the most economical and effective will be finally adopted.

In a recent interview with President Vreeland, of the Metropolitan Company, we were given certain facts regarding the situation, which are timely and significant. The policy of the company in building the cable road on Broadway, and its later extension on Lexington Avenue, and also the proposed underground trolley lines on Eighth and Sixth Avenues, has been determined by the exigencies of an ever increasing and overburdened traffic. So rapid has been the growth of travel in New York City, that there has never been a time when it has not exceeded the capacity of the company's roads. Extensions and improvements have been made under the spur of pressing necessity, and the company has never been able to afford the time necessary for any lengthy experimental work of its own to determine the best form of traction. In all contemplated improvements it has had to choose the best system in sight at the time. This was the case when the cable was chosen for Broadway, and it is the same pressing necessity that causes the company to put in the costly underground trolley on 43 miles of its lines on Eighth and Madison Avenues, before its experimental work with the compressed air motors is completed.

With regard to the cable road, the company is satisfied that, in spite of the high state of efficiency to which electric traction has been brought, and its superior economy under average conditions, the cable is the best form of traction for the exceptionally heavy traffic on Broadway. The fact that electricity is replacing the cable in San Francisco and elsewhere, and showing a higher comparative economy, proves the case only for such conditions as obtain on these lines, where the volume of travel is moderate and the headway between cars is measured by minutes. The Broadway cable road, however, is operated under conditions that find no parallel in any city of the world. The average headway between cars is twenty seconds, and during the "rush" hours it is as small as ten seconds. Add to this that the bulk of the travel on the busiest portions of the line is local, necessitating frequent stops, and one has some idea of the enormous demand that is put upon the power house, and the value of having at command the great reservoir of momentum which is provided by the cable and its miles of moving cars. The problem of transportation on a line where the headway is measured by seconds instead of by minutes resolves itself largely into one of celerity in starting and stopping, and the management and engineers of the Broadway line are satisfied that this is more efficiently solved by the existing cable than it could be by any form of electric traction.

That the company considers this efficiency to hold good only where the burden of traffic is abnormally heavy, is proved by its intention to equip the parallel lines on Eighth and Madison Avenues electrically. These lines are at present operated by horse cars, and the change is being made chiefly with a view of relieving the congestion on Broadway, and incidentally to provide a better service on these lines. The change will affect 43 miles of road. The Eighth Avenue line will extend from One Hundred and Fifty-third Street to Fifty-ninth, and thence by way of Sixth Avenue to a terminus at the lower end of the city. The Madison Avenue line will extend from One Hundred and Thirty-eighth Street to the Post Office by way of Fourth Avenue, the Bowery, and Center Street. The construction and equipment will be similar to that which is used on the Lenox Avenue line, an illustrated description of which was given in the *Scientific American* of February 22nd, 1896. Power for the Madison Avenue line will be furnished from the Twenty-fifth Street power-house, in which will be erected four 850-kilowatt generators, driven by direct-connected engines of 1,300 horse-power. At the One Hundred and Forty-sixth Street station three 850-kilowatt generators will be added to the two 400-kilowatt generators which are already in place.

With reference to the experiments in compressed air traction which the company is carrying out on Lennox Avenue, we are informed that electricity was not chosen for the new lines because of any unfavourable results which had attended these trials, but simply because the experiments had not extended over a sufficient period to allow any reliable data to be tabulated. The results have so far been satisfactory, and two more motors will soon be added to the equipment. The company still has over 100 miles of horse car lines which have yet to be changed to some form of mechanical traction, and if the compressed air motors fulfil their present promise after a sufficiently lengthy trial, they will probably in time be placed on a portion of these lines.

* *Scientific American.*

THE "KOSMO" SYSTEM OF CONCENTRIC WIRING.

A correspondent sends us the following comments:—

"The main principle of this wiring system, that of working from centres of distribution, containing D.P. switches and fuses, is a good method of construction, and to be advised in all cases. The weak points are apparent after leaving the distributing centres, *i.e.*, in connecting and jointing.

"The conductors are said to be mechanically protected by a lead tube, excepting the larger sizes. The lead tube can only be considered as providing partial mechanical protection, and conductors protected by this means, are certainly not suited to the severe conditions met with in new building work, and are easily damaged or spoilt by nails, &c. It would seem that the closer a wiring system follows the present gas-fitting experience in respect to protection from mechanical injury, the greater should be its success. For gas-fitting, lead compo pipes still exist side by side with iron gas pipes, but the tendency is always to give the preference to iron pipe in all cases.

"The points made in respect to adaptability of the lead covered cable to *surface work* in buildings, is greatly discounted by the consideration, that, in all high class work the idea is to *conceal* the wires completely. Doubtless there will always be a field for surface work in old buildings, but it must be one which is always diminishing. A further disadvantage that this method of wiring with flexible leads labours under, is the fact, that, once installed the capacity of electric supply is fixed and limited. Alterations or extensions cause damage and inconvenience. A comparison of the above system with a conduit system shows that this latter has decided advantages in respect to later convenience, although its first installation may present greater inconvenience.

"The tools and accessories for jointing cables have apparently been carefully worked out, but, although the means of jointing may be excellent, the principle can be readily criticised. The use of a wood block and filling compound is certainly disadvantageous, and under practical conditions, it will certainly be difficult to fill the blocks neatly and expeditiously. Perhaps the compound employed, providing it does not soil its surroundings and present troubles on account of change in temperature, may be a more superior method of filling the jointing boxes to the molten metal employed in other systems. The merit of these systems of wiring would seem to be *mainly determined by*

the connecting and jointing facilities, and examination of the various methods followed, points to the conclusion that the correct principle to follow, is that of employing an internally insulated metal box, which can be readily made watertight. In this way, electrical and mechanical protection seems to be gained in the highest degree in respect to economy, simplicity, and effectiveness.

"The growth of these armoured cable systems is significant, as suggesting a growing tendency to distrust the protection said to be obtained from wood casing.

"Each system also calls attention to the design of special jointing facilities, and tools for increasing the productiveness and certainty of the wiremen's labour. Here again that system will have the advantage which employs the simplest tools, and those which can be improvised from existing tools or readily obtained, and at a small cost. The feeling is rapidly growing, that all connecting and jointing, with provision for outlet points, should be a simple, mechanical, and perfect job. Heretofore, wood casing wiring work has always presented difficulties in these respects.

"I think the method of arranging the two conductors concentrically is open to criticism on practical and mechanical considerations. It costs more to make a concentric conductor of a given capacity and given I.R. than a conductor in which the two wires are arranged side by side. Concentrically laid wires are also at a disadvantage in respect to jointing and connecting from the difficulty of making an outlet from the inner conductor through the outer.

"The chief advantage the Kosmo system appears to have over similar systems, is the fact that the number of special fittings and attachments it is necessary to employ have been reduced to the jointings and connections, so that, after the necessary connections have been made, any of the switches, ceiling roses, &c., at present on the market can be employed in connection with it. This is a very important consideration with wiring contractors, both in respect to time saving and cost. From the increasing numbers of wiring systems now coming before the trade, I am inclined to agree with the writer who re-quoted Herbert Spencer and said that we are now decidedly in the 'Disagreement of the Enquiring' stage of electric wiring, and I suppose that it is only time, and an increasing experience, which will show us the "Survival of the fittest," and the final stage in the evolution of wiring—the Unanimity of the Wise."

THE INSTITUTION PRESIDENTIAL ADDRESS.

(*Concluded from page* 129.)

In regard to telephonic and fast speed cables, the President spoke hopefully, but guardedly, as to the fundamental alterations in the structure of cables in the future; and he opined that a day may come when a cable shall be constructed which shall enable us to hold converse by telephone across the Atlantic.

The system of Mr. Preece does not appear to be absolutely original, and similar results would probably be gained by a twin conductor, or groups of conductors, differing in form, section, and arrangement.

The proposed system doubtless raises contentious matter, for which the only real solution appears to lie in practical trials.

The point Mr. Preece raises is whether the proximity of these conductors does not by interinduction produce an effect of sufficient importance to materially improve the conditions for rapid vibration. This, we believe, can only be determined by experiment on a large enough scale, and it is therefore worthy of the attention given to it in the President's address.

As for permanent leaks, or bridges of high resistance between two conductors of a double core cable, it is no doubt in theory sound, and mathematically correct, the high attainments of Prof. S. P. Thompson being sufficient guarantee for that, but as a practical means of improving the speed of transmission of signals through long submarine circuits, we regard it as little short of visionary. A much larger battery power than usual would be required, and we venture to say that a fault of an ordinary kind in the core of such a cable would be extremely difficult to locate, owing to the existence of these high resistance bridges, or distributed leaks between wires at intervals throughout the cable, so that we shall not anticipate a hurried change from the present construction of ocean cables.

If we are not mistaken, the late Prof. Fleeming Jenkin suggested the introduction of leaks on a long line by means of high resistances branching off between the conductor and earth at various points in the circuit. If these designs are the only alternatives, they appear likely to remain pigeon-holed, for the risk of experimenting with an actual Atlantic cable with either of the proposed types would, we think, deter cable companies from financing such a scheme. If mistakes must be made, as the President seems to think will be the case, they should not be too costly, or improvements may be deferred indefinitely. In a multitude of counsellors, however, there is wisdom, and if we may apply this aphorism to our highest authorities in the domain of electrical science, perfection in the quick transmission of signals through under sea conductors may yet be attained.

In dismissing the subject of submarine telegraphy, the President resumed his remarks upon electric lighting, traction, and transmission of power over short distances. He says that in these branches electricity has to encounter formidable rivals. There can be no difference of opinion here. The recent improvements in the burning of coal gas may have checked the more rapid development of the electric light. In the incandescent method of indoor illumination we now have an economical, clean, and brilliant light, which is finding its way rapidly into large suburban business emporiums, as well as into the homes of the middle classes, and is gaining steadily in public favour. When powers are given to some of the electric light companies to deal with new districts, they may find themselves forestalled to some extent so far as domestic and shop lighting is concerned. The extension of the use of gas engines in small factories or workshops is another interfering element, as these may under some circumstances stand in the way of the employment of small electrically-driven motors.

Regarding road and tramway traction, this is another thing. Taking the motor car, which is occupying public attention mostly just now, electrical engineers have it in their own hands to bring the electrical methods to the front. The absence of smell, and of objectionable vibration when standing still, is a great advantage in the electrically-driven carriage. Improved forms of accumulators are now being manufactured by leading firms, all points being carefully studied, and the varied trials that the motor car will be subjected to provided for. The President states that the weight and space occupied by recent forms of accumulators have been nearly halved, and we have little doubt that in the future these will be further reduced.

In tramway traction there are obstacles in the path. The difference between the thoroughfares of English and of American cities will not prevent the single trolley system being adopted largely in this country, but we may also see a still greater development of underground railroads and tramways, in both of which electricity will furnish the motive power.

It is to be regretted that Sir Henry Mance did not more strongly recommend the members of the Institution to closely study and profit by the extended use of electric traction now being carried on in the United States: but perhaps he did not consider this necessary, as traction is one of the late developments, and is therefore prominently before the readers of the technical press. However, among the many pitfalls that the electrical engineer has to avoid, we may indicate the destruction of wrought-iron pipes and lead service water pipes, gas pipes, and lead coverings of underground cables by the electrolytic action of the currents. These contingencies have certainly been met on this side of the Atlantic, but a consideration of the difficulties our trans-Atlantic friends have to overcome cannot but be useful to English practice. The London householder would, indeed, have a grievance if he had to have his lead water service pipe taken into the house overhead instead of underground. In Brooklyn, U.S., the remarkable fact has been demonstrated that cast-iron main pipes are not affected by electrolysis. In an exhaustive report of the Board of Commissioners of Electrical Subways, it is shown that cast-iron mains that have been down 28 years, and during the last two years have been subjected to the passage of trolley currents, have not been injured in any way by elec-

trolysis. The requirements now demanded here for electric subways are stringently preventive of the evils above-mentioned. The electrical bonding of rails needs to be so perfect, that practically the whole of the return current passes through them, or the iron shell of the tunnel, where this construction is available, may serve the same purpose, or other method equally reliable, and the amount of earth current must be strictly within Board of Trade rule.

In the development of the use of current, we may repeat that seaside lines, as pointed out in an article in the Electrical Review of January 15th last, will open up an extensive field for the electric motor. Light railways, both at home and abroad, and haulage in mines, will widen the sphere of usefulness for this "end of the century" mode of locomotion.

Touching upon the subject of electro-chemistry, the President put up an important finger post to direct the attention of the student towards the immense possibilities for the future in this branch of electrical science. Processes have been elaborated and put into active operation already at localities suited to industries of the magnitude which these promise to become.

In electro-metallurgy much work is being done abroad; the electrolytic refining of silver and copper in America was quoted in the Electrical Review of November 27th, 1896, as having assumed vast proportions, and it would appear that precipitation of gold by the electrolytic decomposition of gold cyanide solutions has superseded to a large extent the deposition of gold by the so-called zinc process.

The electrical deposition of zinc from refractory sulphide ores is coming into use in Australia, but has not yet emerged from the experimental stage into practical use.

The problem of obtaining electrical energy direct from carbon is, the President tells us, being diligently pursued by men of scientific repute. There is also the question now before those interested in motor carriages as to whether the primary battery can come in where secondary batteries cannot be readily obtained. On rough roads the primary battery would be preferable, but its adaptability is doubtful, and does not come within the sphere of practical application yet.

The President, in his concluding remarks, said that all were agreed as to the imperative necessity that the Institution should keep in the front rank. Certainly united action of all sections is indispensable to ensure the progress of the Society in its mission of usefulness.

Like the kindred Institution of Civil Engineers, it should stand first and foremost in all that appertains to the diversified applications of its leading principle, and the off-shoots thereof should be brought into accord, and loyally support and co-operate in establishing and perpetuating the Society on the firmest foundations.

The present and future members of Council will deserve well of all branches if they succeed in concentrating their interests, and while gratifying the natural aspirations of any one section, meet the reasonable demands of all.

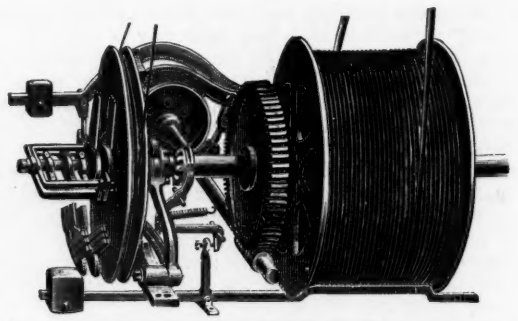
So far as the desire of the present Council goes to accomplish this end, we feel sure that it is unanimous, and it merits the most cordial help in promoting the general good of the Institution.

The importance of possessing a suitable habitation, too, cannot be over-rated, and early discussion of this matter should be strongly urged. Prompt action would, it is to be hoped, as a matter of course, follow. It is time that a Society, with pretensions of a high-class scientific order, should cease to be, in the 26th year of its existence, and with over 3,000 members, under the necessity of craving a lodgment from its kindly neighbour, even though the alternative be a move to a less magnificent place of meeting, for the amount standing to the credit of the building fund is not colossal; in fact, it seems to be little more than enough to purchase a suitable site, so that the financial part of the business will be a knotty point to unravel. Still, let us hope that some liberal donors will give a lead, and that members will generously respond, if more funds are wanted.

To posterity, in the shape of the electrical engineer of the future, will this prospective noble inheritance come to. It is, as the President said, to the student of to-day that the fortunes of this Institution will be entrusted, and most assuredly, with the bright promise for the future for electrical science in its varied branches, as so lucidly set forth in the able and vigorous address of Sir Henry Mance, the younger element of the Society should view with feelings of hope and confidence, coupled with determination to succeed in all things, the prospect for this second quarter of a century of its existence. At the expiry of the term may the student of to-day look back with satisfaction to this, the accelerating point in the career of the Institution, which shall have carried him with it, let us hope, on the crest of an ever increasing wave to the topmost tide of success.

THE LATEST IMPROVEMENTS IN ELECTRIC ELEVATORS.*

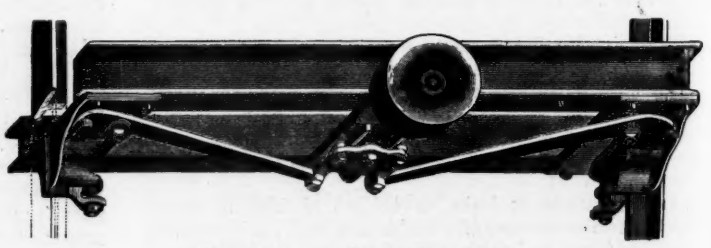
The adaptation of electricity to the working of elevators in buildings has been watched with great interest, and the fact that electric elevators are now achieving a marked degree of success, and coming largely into use, is looked upon with great favour by the public. The illustration on the next page shows a high grade electric passenger elevator for fireproof buildings, the only combustible material used in it being the floor of the car. The motor is anchored to a brick foundation in the basement, and takes up but little space.



The Brake Switch and Automatic Stops on the Machine.

This class of machine is built by the Elektron Manufacturing Company in sizes ranging from 5 horse power to 20 horse power, for speeds ranging from 40 feet per minute to 200 feet per minute, and for capacities from 2,000 pounds to 5,000 pounds. In the small illustration is shown a machine for speeds ranging from 10 feet per minute to 100 feet per minute and capacities from 10 pounds to 500 pounds, while still smaller and larger machines are made.

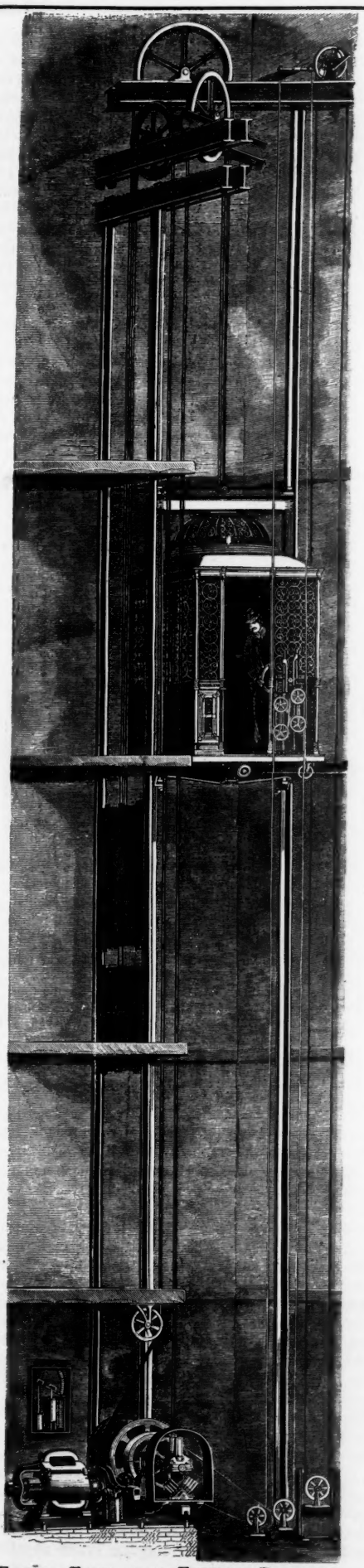
These elevator machines are of the "worm gear" class, by perfecting the design and workmanship of which high efficiency and smooth running have been secured, the efficiency of the passenger gears being proved to be over 75 per cent. The drum, gearing, motor and switch are all mounted on one heavy cast-iron bed plate. The gear is of



The Automatic Safety Car Stop.

gun-metal, with teeth accurately hobbed from the solid, and the worm and worm shaft are made from one steel forging accurately turned in the lathe. Both gear and worm run in

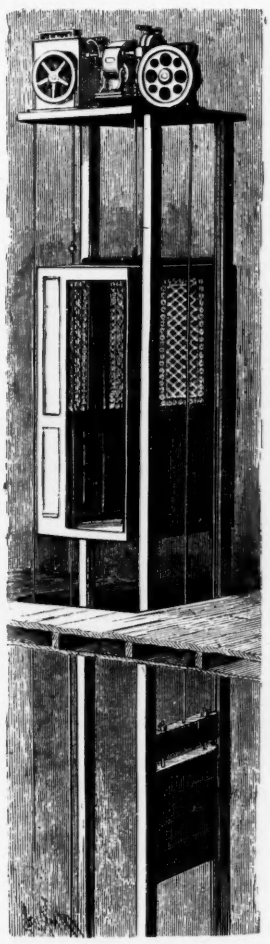
* *Scientific American.*



Electric Elevator for Fireproof Buildings.

an oil-tight case or housing, which also contains the bearings The electric motor is coupled direct to the worm shaft by a heavy insulated coupling, which also serves as a brake wheel. The motors are constructed especially for elevator work, having great starting power, high efficiency and durability. They are heavily insulated from all other parts of the machine, thus obviating all danger of a shock to the operator in the car.

The plant illustrated is what is known as a "six cable job," there being two wire cables from the winding machine to the car; two from the car to the car counter-weight and two from the machine to the machine counter-weight. By this means it is possible to "overbalance the car," and it is found that the best practice is to overbalance equal to the average load. The sheaves over which the cables run at the head of hoistway are of cast-iron, with steel shafts running



A Private Residence Elevator.

in babbitted self-oiling bearings. These bearings are supported by heavy steel beams, which are in turn supported on the walls of the building. The guides for the car and counter-weight are of planed tee iron, with fish plates at the joints, making a perfectly smooth and straight track for the car. The frame of the car is composed wholly of steel channel beams. The cables and safety devices are all attached to this frame, relieving the car of all strain. The car itself sets upon the two bottom beams of the frame and is strongly braced to the side beams. The car, as will be seen, is of highly ornamental iron work, and is usually provided with electric light chandelier and with electric annunciator connected to call buttons at each landing.

As shown in the illustration, the control of the car is by hand wheel, but where preferred on moderate speed elevators the straight hand rope is used. The starting, stopping and reversing is accomplished with the greatest ease and smoothness. The switch, which is shown mounted on the operating sheave at one end of the drum, is very substantial, and, being mounted on a large radius, moves very rapidly as

compared with the movement of the operator's hand; it also breaks contact with a pronounced snap. Troubles with the burning of switch contacts have in this apparatus been entirely avoided. The automatic rheostat is shown attached to the wall back of the machine, and insures a smooth start and prevents blowing fuses, no matter how suddenly the operator may throw in the switch.

In the construction of the passenger elevator, the question of safety has justly received the first consideration. What may be styled the "car safeties" are shown in the large illustration, and also in detail at the bottom of car. An endless rope passes over the governor wheel, which is located on the overhead beams, around an idler wheel at the bottom of the hoistway and several times around the safety drum on the car. This rope is, by a spring pressure caused to move normally with the car. In case of the breakage of the lifting ropes, or in case of excessive speed due to any cause, the centrifugal governor operates a clutch which stops the movement of the rope. As the car continues to descend, the safety drum is caused to revolve, applying a gradually increasing vise grip to the steel guide rails on either side and bringing the car to a gradual stop. The machine also has a complete line of safety devices, as shown in the illustration of the switch and brake mechanism, where may be seen the attachment of the two switch knives directly to the operating sheave. This sheave is loose on the drum shaft and is rotated by the wire rope from the car at the will of the operator. The inner hub of the sheave carries a cam which moves the bell crank lever, raising and lowering the lever of the brake, and the instant the switch knives break contact with the clips the brake is applied.

One of the most important "safeties" is what is called the slack cable safety, also shown in the same view. A bar is located just below the drum and so close to it that there is barely room for the cables to run between when they are taut. If for any reason the cables should become slack, the bar is tipped downwards, tripping a catch and allowing the coil spring to slide forward a clutch on the drum shaft into connection with the operating sheave. A slight additional rotation of drum will carry the sheave sufficiently to open switch and apply brake and stop the machine.

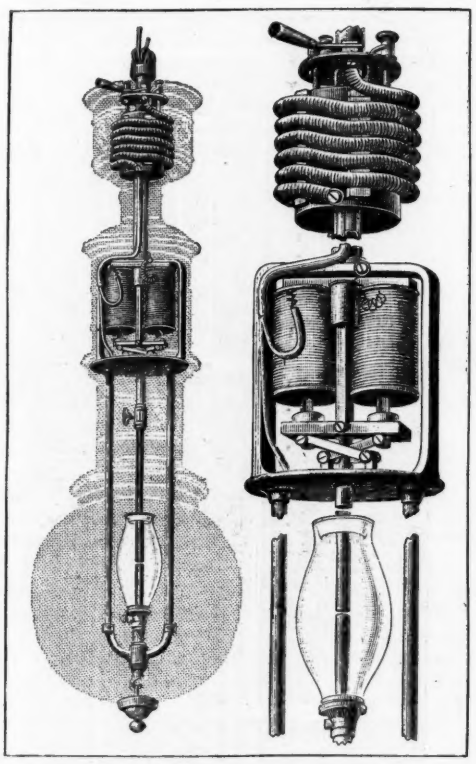
The automatic terminal stop consists of a screw threaded extension of the drum shaft outside of the operating sheave and of a frame or yoke connected with the operating sheave which surrounds the same. On this screw are two stationary nuts and one travelling nut so adjusted that when the car reaches either terminal the nuts will engage, and the operating sheave will be caused to rotate with the drum, when a slight rotation is all that is necessary to open the switch, apply the brake and bring the apparatus to a stop. The elevators are manufactured by the Elektron Manufacturing Company, of Springfield, Mass., with branch offices at New York City, Boston, and Rochester, N.Y. This company were among the first to adapt electricity to levators, and they make direct elevators for both freight and passenger service, ranging in speed from 10 feet per minute to 300 feet per minute, and in capacities from 10 pounds to 10 tons.

MARKS'S ENCLOSED LONG-BURNING ARC LAMP.

We have at various times mentioned the Pioneer long burning arc lamp, but hitherto we have not put before our readers technical details and illustrations of the working parts. These we have reproduced from an article by E. de Lécépé in *La Nature*.

An arc lamp working alone on a system at 110 volts, and only requiring the carbons to be renewed after 150 to 200 hours of lighting, would supply a much-felt want in a great number of private cases, and it is to meet this want that the lamps with enclosed arc, which for the past year have been flooding the market in America, England and Germany have been devised. The particular system that we are going to describe, and which is known in America under the name of the Pioneer, was certainly the first in the field, for its inventor, Mr. L. B. Marks, presented the first results of his researches to the National Congress of Electricians, held at Chicago in August, 1893, under the name of the incandescent arc lamp. In his first experiments Mr. L. B. Marks had only in view an improvement in the steadiness of the light, and in the duration of the carbons; therefore the arc worked at 55 volts only. In the new lamp shown in the accompanying figure, the arc absorbs 80 volts, and the additional resistance 30 volts, which places it, as regards utilisation of electrical energy, to all intents under conditions equivalent to those resulting from the employment of two arcs in series with the ordinary system.

Mr. L. B. Marks's lamp with enclosed arc, shown herewith, only differs from the ordinary arc lamps by the addition of a little inner egg-shaped globe of opal glass in which the gases resulting from the combustion of the carbons are kept imprisoned by virtue of the cap at the top, which is almost completely air-tight, without, however, impeding the movement of the upper carbon, which is necessary for the regulation. A simple arrangement enclosed in the upper part of the lamp allows of the formation of the arc and the advancement of the upper carbon. This mechanism consists of two fixed solenoids, the movable cores of which are attached, by



means of two levers crossed to jaws, which press against the rod that supports the upper carbon and hold it tight. When the current is weakened, these jaws relax their hold, and allow the rod to slip downwards; but this downward movement takes place imperceptibly, owing to the slow consumption of the carbons. The regulator contains no weight, no spring, no wheel, and no complicated system of regulation.

The resistance introduced into the circuit for the purpose of absorbing the 20 or 30 volts represented by the difference between the 80 volts required by the lamp, and the 100 to 110 volts supplied by the distribution, is arranged at the top of the lamp in the form of a long spiral wound in a helix. This arrangement, which is suited to the installation, which it simplifies, has the drawback of somewhat extending the length of the lamp.

The voltaic arc produces in the gases confined in the closed globe a peculiar appearance; the positive carbon is hardly hollowed at all, and the negative one remains to all intents flat. With 80 volts at the terminals of the carbons, the arc has a length of about 8 millimetres. With very pure homogeneous carbons 12 to 13 millimetres in diameter, the consumption of the carbons in an arc of 5 amperes is not much more than ·5 mm. per hour for the lower negative carbon,

and 1·4 mm. for the upper positive carbon. Under these conditions, the luminous point remains practically fixed in the space, and the negative carbon, after having played its part for 150 to 200 hours as negative, is taken as positive for a second period of the same duration, with a new negative carbon, which will be taken as a positive one in its turn, and so on. Each renewal of carbons, each trimming, to use a new term that is now often employed, thus required only one new carbon.

By virtue of the length of the arc, the positive carbon is very free, and the shadow cast by the carbon very small; but the arc does not cover the whole surface of the positive carbon, but travels continually over this surface, displacing the point of emission. Comparative results of ordinary arc lamps, and lamps with enclosed arcs under the conditions of their respective practical employment, are as yet wanting, so that any expression of opinion on this subject would be premature.

Such are the more recent features of Mr. L. B. Marks's lamps with enclosed arcs.

Besides the advantages resulting from the use of independent lamps, and the saving in the renewal of the carbons, the lamp with enclosed arc presents certain others of less importance, but quite as much appreciated by consumers under certain circumstances—such, for instance, as cleanliness, insects and dust not being able to penetrate into the closed globe where the arc is produced, the absence of danger of fire from falling pieces of incandescent carbon, the reduction of height of the apparatus, which enables it to be more conveniently installed, the simplicity of the regulating mechanism, &c.

These advantages, however, are counterbalanced by certain drawbacks, which our impartiality obliges us to mention without being in a position to prove their truth, for they are brought forward by rival makers. The most serious consists in the decrease in light of the luminous focus, caused partly by the form of the carbons and partly by the employment of two globes, one of which is opal, and which absorb at a pure loss an important fraction of the light emitted by the arc. In time, too, a deposit is formed on the inner surface of the closed globe, which also absorbs a considerable portion of the light.

Moreover, the violet rays emitted by the long arc are larger than those emitted by a short arc, and these rays are lost for the luminous effect. Lastly, as the arc travels in the cylinder of heated gases limited by the practically flat extremities of the two carbons, seeking the point of least resistance, it produces at each moment a variation, if not in the total luminosity, at least in its intensity in a given direction, a defect which is very little modified by the presence of the opal globe.

All these causes of loss and irregularity combine to render the enclosed arc less economical than the ordinary one, even if we take into account the reduction of expense in the renewal of the carbons. We have not any results of comparative experiments made by an unbiased authority to help us to determine the value and importance of the defects that we have just mentioned. These defects may be prohibitive in certain applications, but there are many other cases in which they are considered of little importance, if we may judge by the number of orders for these lamps, and by the number of lamps with enclosed arcs that have been patented in less than a year. If, according to the proverb, *the proof of the pudding is in the eating*, the proof of the value of the system is in the favour with which it has been received by John Bull and Uncle Sam. At a time when the name of the inventors of lamps with enclosed arcs is legion, we take the opportunity of paying homage to Mr. L. B. Marks, who was the first to succeed in a path where many had failed, and who deserves for himself the name of *Pioneer*, under which designation his lamp made its entry into the world.

THE IRONY OF SCIENCE.

In the course of our journalistic duties we have had on many occasions to call attention to the want of knowledge displayed by writers in quasi-scientific journals and newspapers when dealing with electrical topics, but never during our whole career have we come across such an example as that displayed in the first of a series of articles entitled "Electric Light Fitting," which appears in the February 1st issue of *The Hardware Trade Journal*, from the pen of "A Practical Electrician." The definition of units require no comments from us; our readers can make their own, not loud, but deep.

The Volt.

This term is said to be due to the Italian scientist, Volta, and denotes the difference of potential of electrical currents. In text-books it is written E.M.F., or electromotive force. Its relation to electric current is similar to head or pressure as used in hydraulic work, where the pressure of a column of water of a given height is equal to a pressure of pounds per square inch, and must be understood to mean literally the pressure exerted by a power to force the current of electrical energy through a conductor, or rather to energise the conductor so that a given quantity of current is delivered at a given point.

The Ampere.

This term is attributed to M. Ampère, a French mathematician, and represents the quantity of current produced, either by the destruction of metals in a battery by chemical combination, or by the combustion of fuel in a steam boiler, the heat from which causes the expansion of water into steam, whose elastic force causes a suitable engine to produce motion in a dynamo electric machine, the inductive qualities of which produce quantity, or amperes, of electric energy.

Volt-Amperes.

These represent the electrical horse power (H.P.) necessary to the production of pressure (volts), and multiplied by the quantity (amperes), or, more correctly, the H.P. represented by the combination and given off at the terminals of a battery or dynamo. Text-books call volt-amperes "watts"; dynamo machines are known to yield so many "watts," and the measurements of currents in meters are represented by this term. The Board of Trade have adopted the "watt" as a standard unit, by which it is possible for public companies who produce and sell to consumers to charge a given sum per "Board of Trade unit"—viz., 1,000 watts, measured by a watt meter. To enable this to be understood more easily I give an example:—The number of watts representing an electrical H.P. is 746. Therefore, if we have a dynamo producing a current of 50 amperes at 100 volts, 50 × 100 = 5,000 watts, or 5 B.T. units, and represents 6¾-H.P., nearly.

The Ohm.

This, a unit of resistance, and is again the discovery of a French chemist, M. Ohm. It represents the amount of resistance offered by the material in a conductor to the passage of an "ampere of current," at a pressure of 1 volt. To grasp this more fully, and in a simple manner, let me say it has been calculated that a copper wire, 129 yards long × $\frac{1}{16}$-inch diameter, has a resistance of 1 ohm. Therefore, if a current of 1 ampere is delivered at one end of this wire at a pressure of 1 volt, no current would result at the other end, as the resistance would exactly counterbalance the energy. This is a most important point for the would-be electrical engineer or fitter, and has to be reckoned with in every transaction. A neglect in providing sufficient conduction has often proved fatal to an otherwise perfect installation of electric plant. To avoid waste and rule-of-thumb calculations, the student must make himself thoroughly acquainted with the above rules. Not only does this resistance apply to conductivity of wire, but, in electric light fitting, there is another resistance to be reckoned with: this is the insulation of the conductor. It is now the rule to cover all electric light wires with a material that is the worst possible conductor, so that current shall not be lost by escaping to any other conductor, by which it may get to earth, or perform work or mischief other than that intended. The various manufacturers of cable and wire issue a table corresponding to the various coverings, and their resistances may generally be taken as correct; but many of your readers will probably have to purchase wire of factors who may not be able to supply the information, or, if so, only from imagination. Hence it will be necessary for the electrical fitter to test for himself. As I cannot, however, in this article give detailed instructions for testing, I shall do so in another, at a later date.

To revert to the further consideration of terms. The foregoing are essential to even the simplest operation, and familiarity with their use must become as ABC to the student, as well as the practical fitter.

Other Terms.

There are, however, other units established, more, perhaps, for the use of the laboratory and instrument makers, and for those who have to calibrate and balance delicate apparatus, and which I only mention here. C.G.S. represents "Centimetre Gramme Second," and is what is termed a unit of measurement by which it is possible to measure an imponderable fluid, as electricity, and is an "absolute unit," embracing time absorbed by a current passing through a conductor, as, say, 1 ampere at E.M.F. of 1 volt may pass a conductor 1,000 feet long in 1 C.G.S., and has produced, say, 1 calorie—*i.e.*, the heat evolved by the operation. C.G.S. means, essentially, a method by which it is possible to measure electric current, and by which we again arrive at "The Dyne," or the absolute unit of force, that force which, acting for one second of time on a mass of 1 gramme, imparts to it a velocity of 1 centimetre. The work performed is represented by "The Erg," which is the absolute unit of work requisite to propel a body 1 centimetre against a force of 1 dyne, and is equal to $\frac{1}{13,560,000}$th foot-pound. Megohm = 1,000,000 ohms, and is used in determining the resistance of insulation material to the passage of

electricity. "Calorie" is a unit of heat, capable of raising $3\frac{1}{10}$ lbs. of matter 1 foot high, and will raise the temperature of 1 gramme of water 1° Centigrade. The heat produced by a passage of current through a copper wire increases as the difference of the quantity (amperes) and the section of the wire. This will be practically discussed in a future article. I will close this by saying that, in practice, the resistance of copper wire is increased 21 % for every degree Fahrenheit of the rise in temperature.

(To be continued.)!!!

In introducing his subject, the writer blandly states: "I shall endeavour as far as possible to avoid the more mathematical details, being conscious that many readers will not have acquired a knowledge of working out mathematical formulæ, and that to them the ordinary text-books are as obscure as a Greek lexicon; although it must be confessed these formulæ cannot be entirely ignored since the new language and technical terms that have been brought into use by the introduction of electrical science must be understood."

And yet it is said that technical education in this country has been neglected!

MUNICIPAL INSURANCE.

It cannot be denied that the discussion on Mr. Councillor Pearson's paper on "Municipal Insurance" was, generally speaking, of a practical character, and on the main points of the question there was unanimity among the members. The first speaker, Mr. Councillor Longbottom, of Huddersfield, had come to the conclusion that municipalities would do well to become their own insurers. He sent a thrill through his audience by saying that he had seen electrical stations which were in great danger from fire; others, however, were built in such a way that it was impossible for fires to occur. The speaker gave an interesting account of a mutual insurance system effected by builders in the town, with which he was associated, to cover claims that might arise under the Employers' Liability Act. The plan worked so well that they had about half the premiums returned in bonuses every year. He pointed out the advantage that had accrued to one large shipping firm by dropping their insurance premiums, with the result that they had been able to build a new ship every year.

Alderman Higginbottom is one of the best known speakers at the municipal engineers' meeting, and his remarks generally tend to advance the subject. He had expected that the discussion would have been confined to the insurance of electric lighting stations, instead of a general discussion on the advisability of insuring municipal buildings as a whole. He did not approve of municipal corporations forming themselves into a combined association for insurance. They had no power to do this, apart from the difficulty of assessing the various risks. Coming to the question of each corporation being its own insurer of municipal property, the speaker gave some interesting figures as to the extent the Manchester Corporation insured its buildings. £669,000 represented the total amount of insurance, the average premium being 2s. 9d. The curious feature of the figures, and one which threw a little light on the fire office methods, was that the Public Libraries were charged a premium of 1s. 6d. During the past 20 years they had paid in Manchester £12,300, and had drawn out £3,611. The speaker's views were clear and decided enough on the insurance of electric lighting stations, and he maintained that if a profit was being earned, a portion of the profit ought to be set aside for fire insurance. If they were not making a profit, they ought to continue the insurance with a company.

Mr. Vesey Brown, the borough electrical engineer of Lincoln, raised a very important point in his remarks. He very truly observed that there was little need to insure a central station, but danger of fire from external sources was sometimes great. He instanced Lincoln, where the site of the station was between a flour-mill and a saw-mill. The speaker made a good point in favour of mutual municipal insurance by pointing out that small towns, such as Lincoln, would obtain most benefit under such a scheme, for in large towns, such as Manchester, it would take probably a farthing in the £ to replace any damage, while in Lincoln £20,000 worth of damage would prove a serious drain on the ratepayers.

Mr. Alderman Ellis, of Portsmouth, spoke of the heavy rates asked by insurance companies, with the result that they were insuring themselves. Before doing that, however, they had been well provided with fire hydrants, and the men were drilled to cope with any possible outbreak of fire. He agreed in the main with Alderman Higginbottom that it was necessary to put something aside out of profits to form a renewals and contingency fund. Mr. H. L. Boot, of Tunbridge Wells, elaborated at considerable length a scheme of mutual insurance, a working committee being formed of one representative from each town. Alderman Porter, of Taunton, let a little daylight into insurance company methods, and showed that in the case of their sub-stations, which were safer than their generating station, they paid a higher premium. Alderman Calvert, of Huddersfield, was followed with some interest, for Huddersfield is one of the towns that in the early stages of the disputes with the fire offices adopted the courageous attitude of refusing to insure at enhanced rates. He apparently believed in Corporations becoming their own insurers, but did not look kindly upon the scheme of mutual insurance. Mr. Ram, the Coventry engineer, spoke from his experience of the ignorance of fire inspectors, and Mr. Wright's account of what the insurance companies had done at Brighton verified the general opinion that fire offices were given to act in an illogical manner. When they had a wooden station 2s. 6d. was the premium; but as they gradually made the works more fireproof, the premiums were gradually raised, until when the works were practically fireproof, the fire offices asked 10s. 6d. They had eventually accepted an offer of 5s. per cent. Mr. Pycraft, the chief clerk of the St. Pancras electric lighting department, thought if they could collect details of the total sum insured, and the amount of premiums paid, the information would prove to be of great use. Alderman Woodhead, of Halifax, spoke of the value of mutual insurance as exemplified by a trading instance in Halifax. Mr. Madgen thought it would have been interesting to have heard the insurance companies view of the matter. Mr. J. H. Rider considered the best arrangement for Corporations would be to drop the insurance of one property at a time, until the sum set aside had reached a considerable amount. Mr. Albert Gay, of Islington, said that the fire offices should be pressed to grant a sliding scale, according to the safety of the station.

A few remarks from Mr. Couzens, of Taunton, and Mr. Faraday Proctor, of Bristol, and Mr. Wordingham, brought the discussion to a close.

As we have already said, there was great unanimity among the members present, and the resolutions which we published last week were the real and practical outcome of what was an exceedingly useful discussion.

The Municipal Electrical Engineers are to be congratulated on the manner in which they have considered the question of fire insurance; they have arrived at decisions which will strengthen the hands of electric lighting committees in resisting the demands of the insurance companies.

Although the resolutions were given in our last issue, it will be useful to give them again:—

"That, in the opinion of this Association, the action of the insurance offices in raising the rates of premiums for the insurance of electric generating stations is quite unjustifiable, and in their opinion some joint action on the part of municipalities is called for in consequence."

"That, in the opinion of this Association, the most feasible method of providing against risk for fire in electric generating stations is for each municipality to set aside each year from the gross profits a certain sum to form a fund for the purpose of meeting such risks; and where the profits do not admit of such sum being set aside, it is desirable to insure in those offices which are willing to investigate each risk on its own merits."

"That, in the opinion of this meeting, it is desirable for the Committee of this Association to ascertain the capital insured in electric lighting stations (excluding the cost of mains and the capital involved in the laying of mains), the premiums paid, and, if possible, the bases of assessment made by the insurance companies, and to report the result of their investigations at the annual convention."

THE "UNIVERSAL" ENGINE.

On Friday, the 29th ult. a party of engineers and journalists visited the Falcon Works, Loughborough, to inspect the performance of a "Universal" triple expansion engine built for driving a cotton mill in north Italy.

The engine is of 330 I.H.P. and was temporarily coupled to an inductor alternator of 100 kw.

The running of the engine was apparently perfect, the needle of the tachometer remaining quite steady throughout the run.

As the principal interest lay in the suitability of the engine for traction purposes, experiments were tried to determine the variation of speed under large and sudden variations of load.

To enable this to be done, the external load was arranged on two circuits of 50 kw., each controlled by trigger switches.

Half load was switched on and off repeatedly without any visible effect on the tachometer. The whole load was then switched off and the exciter stopped, but the extreme movement of the needle did not exceed one degree, representing two revolutions per minute of the engine.

This result, unexpected on the part of the visitors, shows conclusively that a triple expansion engine may be governed with precision notwithstanding that there are two receivers between the steam-pipe and the condenser.

In this case the governor controlled the high pressure admission valve only.

The particulars of the engine are as follows :—

High pressure cylinder	16½ inches
Intermediator	25 "
2 low pressure, each	25 "
Stroke	10½ "
Revolutions...	300 "

It is intended to work with superheated steam supplied by a Babcock boiler at 180 lbs. pressure and with a vacuum of 26 inches, but as the Falcon boilers give only 140 lbs. pressure and condensing water is scarce, the mean initial pressure was only 110 lbs. and the vacuum 21 inches, nevertheless the steam consumption was under 16 lbs. per I.H.P. which Mr. Raworth estimates as equivalent to 12½ lbs. under the specified conditions.

On the conclusion of the trials two other combined sets were shown in operation, one of 30 H.P., for the Italian Navy, and one of 165 H.P., for the River Plate Electricity Supply Company.

The Brush Company appear to be doing a fine business in "Universal" Engines for the works are literally full of them.

THE ALL-BRITISH TRANS-PACIFIC CABLE.

In *Blackwood's Magazine* for this month we find a lucid and interesting article dealing with the project of laying an all-British cable across the Pacific. The writer is apparently well informed on his subject, which is presented in such a way, that there is no difficulty in following the progress of this scheme from its inception up till the present time. There are, in our opinion, one or two points on which a little more information might have been given, notably, on the inattention paid to the unanimous resolution passed at the Colonial Conference in 1887, 10 years ago, as to the advisability of a line of soundings being run along the proposed routes. A half-hearted attempt, abandoned before it was half completed, was made by the Admiralty, who, in this, have after all only followed precedent. It may interest some of our readers if we here reproduce the reply received by Mr. (afterwards Sir) Francis Ronalds, F.R.S., from Mr. (afterwards Sir) John Barrow, secretary of the Admiralty. The letter was dated August 5th, 1816, and related to the adoption of the (then) novel method of communicating by electric telegraph. It runs as follows :—

"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him, with reference to his note of the 3rd inst., that telegraphs of any kind are now wholly unnecessary, and that no other than the one now in use will be adopted."

It was doubtless on some such official precedent as this that the Hydrographer to the Admiralty reported that "any scheme for multiplying the lines of communication to Australia should be in the direction of triplicating, by means of sea cables, those portions of the existing route which are now duplicated by foreign landlines."

As to the depth of water met with in the Pacific, those unfriendly to this project have made abundant use of a slip on the part of one of the witnesses at the Colonial Conference of 1887, when 12,000 fathoms was given as an existing depth in the Pacific ocean; this, of course, is utterly incorrect, as the depth along the proposed routes exceeds by little, if anything, the depth of water in which at least two of the present cables in the Atlantic have been laid. This erroneous figure was made use of by the Ministry of South Australia, on the information of Mr. C. Todd, as an excuse for declining to contribute towards the cost of the proposed survey of the cable route. It is true that these gentlemen may also have been influenced by the fact that South Australia is financially interested in the trans-Australian landline, which would probably suffer considerably when exposed to the competition of a cable across the Pacific Ocean.

We observe that the author of the article we are treating of states that the longest existing cable is 2,563 miles in length; the Brest-St. Pierre cable of 1869 is, however, longer, being more than 2,700 miles in length; it is true that this cable has been interrupted for a considerable time, but that we would ascribe not to its length, but to the method of its construction.

There is also another statement with which we are not in accord. We find that there are five routes set down as available for telegraph communication with India and Australia; this does not appear to us to be an accurate statement of the case, as some of the routes described converge before reaching India or Australia, and therefore should not be dealt with as separate lines, as the strength of a chain is governed by the strength of the weakest link.

BOROUGH OF BRIGHTON.

Report of the Lighting Committee.

The Lighting Committee present herewith a report they have received from their electrical engineer on the subject of the charge for electricity supplied from the Corporation Works :—

[copy.]

"The Brighton Corporation Electricity Works,
"*January 22nd*, 1897.

"Gentlemen,—You are doubtless aware that it will be impossible for some weeks to determine the exact financial result of the past year's working of this undertaking, but I am glad to inform you that in all probability a net profit has been made greatly exceeding that of any previous year, and that you will be enabled thereby (after benefiting the general district fund by the amount already fixed) to bring up the reserve fund to the satisfactory figure of £5,000.

"We have always agreed in Brighton that the success of any municipal electrical undertaking must be chiefly judged by the average consumption per inhabitant, and it is undoubtedly most gratifying to note that while the *general use* of electricity by our ratepayers is far and away ahead of that of any other town in the United Kingdom, the policy of judiciously lowering the tariff from time to time has resulted in your being able to place the undertaking in the extremely sound financial position of having earned and placed in reserve a contingency fund equal to any call that can reasonably be expected to be made on it for several years to come.

"The financial success of the Brighton system of charging, coupled with the fact that some 29 other towns throughout the country have already decided to adopt it, is strong enough evidence of the commercial soundness of the principles on which it has been based.

"From last year's results, we actually find that the only extra cost the Corporation are now put to in having to continue to supply electricity, after the plant, &c., has been got ready for the purpose, amounts to merely *five-eighths* of a penny per unit. In other words, supposing each consumer last year paid the cost of getting ready the plant, &c., necessary for his wants, amounting to ¼d. per lamp per day demanded, and was then charged for all the electricity he consumed at the rate of ¾d. per unit, the result of the year's working would have shown a net profit of close upon £1,000. As, however, our initial price of 7d. for the first hour each day does not yet quite cover the cost of getting ready and running during that hour, there still remains a loss on the sale of the 7d. units, which has obviously been made up out of the profit arising from the sale of low price units.

"In an electric lighting business, such as ours, which has been established for over five years, one can forecast pretty accurately the sale of electricity for the ensuing year. Thus, by taking the consumption of the consumers actually now connected, and assuming

that at least our present rate of connecting new ones will continue, I have little doubt but that about *two million units* will be sold in Brighton in 1897.

"Now, if all the units, after the first hour's daily use at 7d., were charged at a penny each, the entire expenditure would be covered by the revenue. As, however, something undoubtedly ought to be put aside every year to the contingency fund, I strongly recommend you for the present year to fix the charge for the low price units not at 1d., but at 1½d. *This will ensure our making an adequate net profit, while at the same time it will give a very considerable impetus to the use of electricity in private houses and for motors.*

"This alteration in the tariff will greatly benefit the general body of ratepayers, who will, through their district fund, get the electricity consumed by the street lamps at something under 2d. per unit, instead of at 3½d. It will also have the effect of reducing the average price paid by private houses and shops from about 5d. to 4d. per unit.

"You will be gratified to note that our continued endeavours to encourage the daytime use of electricity in Brighton resulted in there being no less than 300,000 units consumed during the daylight hours of last year by electric motors and basement lights.

"This success will, I am sure, convince you of the wisdom of continuing to stimulate the business by giving to those ratepayers who produce the profits rebates proportionate to such profits.

"It should be borne in mind that a tariff of 1½d. after the first hour will make electricity, if it be used regularly, as economical for power purposes or for cooking as the average gas engine or stove. It will enable the few remaining establishments in the town which have generating or motive power plants of their own to get a supply from the Corporation mains at a price which can be readily shown to be much lower than the present cost to them. Such a tariff will also enable us to supply motor car batteries and the sea-shore tramways at an encouraging price

"There are probably some 60 or 70 gas engines still running in Brighton, and the many hours these are in use each day make it just as well worth our while to encourage their substitution by electric motors as it does for us to cater for the daytime users of artificial light.

"I am convinced that the effect of this tariff, which I strongly advise you to adopt, will considerably reduce our expenses per unit in supplying electricity to the ratepayers in general, *as it will still further diversify the classes of the consumers supplied, and thereby spread out over the day the useful duty done by the plant and mains.*

"I am, gentlemen,

"Your obedient servant,

(Signed) "ARTHUR WRIGHT,

"*Electrical Engineer.*"

The committee recommend that the initial charge of 7d. per unit for an average of one hour per lamp per day shall be continued, and that the charge for electricity over such average shall be reduced from 3d. to 1½d. per unit.

On behalf of the Committee,

(Signed) CHAS. J. GALLIERS,

Chairman.

Town Hall, Brighton,

January 25th, 1897.

WEST HAM ELECTRIC LIGHTING TENDERS.

WE have received the following copies of correspondence, &c., from the Electric Construction Company, Limited, for publication:—

[COPY.]

From the Minutes of the Council of West Ham, January 26th, 1897.

The Highways and Parks Committee reported that they have had under consideration a letter from the Electric Construction Company, Limited, with regard to the recent tenders for the electric lighting installation, of which the following is a copy:—

The Electric Construction Company, Limited,
Dashwood House, New Broad Street,
London, E.C., *December 23rd*, 1896.

The Corporation of West Ham, Town Hall, Stratford, E.

Gentlemen,—We think it our duty to communicate with you respecting the contracts for the electric lighting installation, for which you recently publicly invited tenders.

Shortly after our tender was submitted, a person informed us verbally that he could obtain for us the assistance of a member of your Corporation in getting the contract, if we were prepared to negotiate for his services.

The overture was at once rejected, and we thought nothing more of the matter until our attention was drawn to the report in the *Electrician* newspaper of the tenders you had accepted for the several sections of the installation.

We now find that this company's tender for Section A of the installation (engine-house plant, including dynamos, &c.), was, with Willans's engines, £8,810; with Belliss's ditto, £7,717; and with McLaren's, £8,325. The amount of the tender accepted is £9,600 (£1,275 above our highest quotation).

This company's tender for Section C (switchboards, &c.), was £580. The amount of the tender accepted is £633 (£53 above ours).

Section E (Transformers).—This company's tender was £1,203; the amount of the tender accepted is £1,453 10s. (£250 10s. above ours).

Section G (Arc Lamps).—This company's tender was £2,508; the amount of the tender accepted is £2,530 (£22 above ours).

In the circumstances, will you excuse us for inquiring whether the published figures are correct? If so, we should feel greatly obliged by an explanation why our tenders, seeing they are lower than those accepted, have been declined.

We are quite confident that any competent and impartial engineer would inform you that the electric plant manufactured by us is at least equal in quality to any on the market.

In making our request, we ask you to consider that the preparation of the plans for the installation and of the tenders involves a good deal of trouble and considerable expense, and that the invitation of public tenders is a moral obligation, that the offer most advantageous to the Corporation would be accepted.

We await the favour of your reply, and are,

Gentlemen, your obedient Servants,

THE ELECTRIC CONSTRUCTION COMPANY, LIMITED,

JAMES GRAY, *Secretary.*

Your committee are of opinion that the first portion of the letter contains an insinuation of so serious a character that the company should be asked to furnish further particulars with regard to the person referred to, in order that the matter may be fully investigated.

With regard to the latter portion of the letter, your committee, having heard further explanations from the electrical engineer, recommend that the company be informed that, after most careful consideration, the tenders have been accepted which the Council have been advised are most advantageous to the borough.

[COPY LETTER.]

Town Hall, West Ham, E.
January 29th, 1897.

Sir,—I am now directed by the Council to advert to your letter of the 23rd ultimo with regard to the tenders accepted for the electric lighting installation, and to inform you in reply that the Highways and Parks Committee, who had the matter under their consideration, have brought up a report, of which I enclose a copy, which has been adopted by the Council, and I am to state that the Council will be glad to receive the information asked for therein at the earliest convenience of your company.

I am, Sir, your obedient Servant,

(Signed) FRED. E. HILLEARY.

James Gray, Esq, Secretary,
Electric Construction Company, Limited,
Dashwood House, New Broad Street, E.C.

[COPY LETTER.]

The Electric Construction Company, Limited,
Dashwood House, New Broad Street,
London, E.C., *February 2nd*, 1897.

Fred. E. Hilleary, Esq., LL.D.,
Town Clerk, West Ham.

Sir,—I have to acknowledge receipt of your letter of 29th ultimo, enclosing copy of a report of your Highways and Parks Committee on my letter of December 23rd last, for which I beg to thank you.

My directors are disappointed that the committee do not in their report offer any explanation of their recommendation to the Council to accept tenders for your electric installation £1,600 higher in amount than those submitted by this company.

These tenders were all based on your Council's own designs and specifications of certain carefully described work to be executed to the satisfaction of the Council's own engineer, and it is not *ex facie* intelligible how it can be advantageous to the borough to pay to one set of contractors £1,600 more than the price at which other contractors, against whom no valid objection can be made, offer to do precisely the same work.

In this aspect of the case alone, irrespective of the incident set forth in my letter of December 23rd (the gravity of which your committee seem to recognise), it might have been expected that the committee would have welcomed the opportunity offered by our letter, and by some adequate explanation justified, not merely to those who tendered for the works, but to their own constituents, their otherwise inexplicable recommendation.

My directors agree with your Committee that the circumstances involve an insinuation of a serious character, and would be glad to assist your Council in a full investigation, but seeing that more than a month was allowed to elapse, and the sanction of the Local Government Board to the expenditure in question obtained, before the Council replied to our letter calling attention to the subject, my directors infer that there is no great desire for a full investigation.

If, however, the Council take steps to secure an independent inquiry, the particulars asked for will be fully disclosed, along with further information bearing on the subject which has come to light since the date of our letter of December 23rd.

My directors consider the matters dealt with in the correspondence of so great public interest, that they are forwarding copies to the Local Government Board and to the public Press.

I am Sir, your obedient servant,

THE ELECTRIC CONSTRUCTION COMPANY, LIMITED,

JAMES GRAY, *Secretary.*

CORRESPONDENCE.

On Electrical Terms used by Physiologists.

May I ask space to defend my use of the barbarisms, zincative and zincable? A normal mass of protoplasm is isoelectric, but if locally injured or otherwise excited, gives current (through the galvanometer) from normal to disturbed protoplasm, and it is usual to say that normal is electrically negative to disturbed protoplasm. The further terms "electro-negativity of injury," or "of action," "wave of negativity" are derived from this consideration, and to the best of my knowledge universally employed in physiological monographs and text-books (my own included).

I have, however, always been careful to correct the misapprehension between "positive" and "negative" in this polar sense by insisting on the analogy between the current in protoplasm from active to normal (in the galvanometer from normal to active) and by adding that in reality active tissue is the analogy of the zinc of a voltaic couple, *i.e.*, electro-positive, and that by the "negative" of physiological literature we should everywhere understand "positive." But to write in this fashion would lead to hopeless confusion, and I, for some years, compromised by giving active protoplasm as "electromotive," resting protoplasm as "electromobile." The last word is, however, subject to the same ambiguity as that which has corrupted the term "excitable." By saying, *e.g.*, that a muscle is more excitable, it may be meant either that it will respond to a weaker stimulus, or that it will give a greater response to a given stimulus, *i.e.*, either that it is more "erregbar" or more "leistungs fähig." Evidently a similar ambiguity would arise from the word "electromobile."

To make even the elements of the subject at all clear, we require adjectives to indicate that physiologically active tissue where chemical activity is raised, is like the generating plate of a voltaic couple electro-positive, and that resting tissue is capable of being rendered electro-positive by excitation. The comparison is made, and the ideas expressed by saying that active tissue is zincative, resting tissue zincable.

But this is not all—in the more complicated problems of electro-physiology, we shall find that the ordinary phraseology altogether breaks down. How, *e.g.*, can one make intelligible even such fundamental and comparatively simple phenomena as Bernstein's electrotonic decrement, or Hermann's polarisation increment. We want substantives as well as adjectives to express the facts that "*the capability of becoming negative*" (in reality electro-positive) is increased under anodic influence and decreased under cathodic influence. This is conveniently expressed by saying that the zincability is increased under anodic influence, &c.

I cannot further pursue the defence of my barbarisms without undue trespass on your space, and will, therefore, conclude by urging (1) that we must have two pairs of adjectives and substantives to convey the ideas; (2) that it is important to correct the idea conveyed by the "negativity" of physiologists; and (3) that it would lead to hopeless confusion to reverse the word. Zincative, zincable, zincability, zincativity are not elegant, but they are very convenient, and without disrespect to your editorial opinion, very clearly "informative" of the elementary principles of animal electricity, and very explanatory of several verbally mysterious phenomena. Give me prettier words answering the same purpose, and I will gladly drop my barbarisms.

Augustus D. Waller.

January 25th.

Outside Work.

The thanks of all connected with outside central station work are due to you, for your article on the above. I write from experience, gained during several years, in testing, laying, and maintaining conduits and mains and general outside central station work. In many instances an engineer is appointed thoroughly qualified to take charge of the station plant, but with a very limited *practical* knowledge of outside work, with the result that not only the mains, but outside work generally, suffers from the station's earliest days. Many central station engineers are inclined to look upon their outdoor foreman, or superintendent, as a species of superior navvy; now this is certainly unfair, for, if he is a thoroughly experienced man, his experience has probably been bought in quite as hard a school as the resident engineers. Bad joints are, undoubtedly, one great source of trouble, but there are many other weak points, viz.: conduits badly laid; positions of draw-in boxes, often badly arranged; cable roughly handled during drawing-in; ends of cable (especially compound cables) often left in boxes (and armoured cable, in the ground), not properly sealed; badly designed mechanical joint boxes and fittings; wipe joints on compound lead-covered cables badly made; sub-stations badly arranged and fitted up, &c. In many instances, cable manufacturers do not take sufficient precautions, to ensure the proper handling, jointing, &c., of their cables, thus casting discredit on their goods, when the trouble caused, often lays in the manner cables have been treated, after leaving their works.

W. Illingworth.

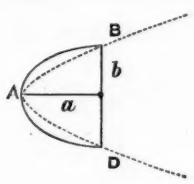
January 27th, 1897.

The Value of π.

I notice in a letter published in your January 22nd issue from a correspondent, "R. C.," that he has apparently deduced a value of π, which is a fallacy. I venture to suggest that the apparent fallacy is due to an error in his calculation.

For the area of the semi-ellipse B A D $= \frac{a\,b\,\pi}{2}$. Now, the area of a parabolic segment as shown by dotted lines $= \frac{4}{3}\,a\,b$.

Now, these two areas can by no means be equated unless



the axes of the ellipse become infinite, in which case it becomes a parabola, and the value $\frac{a\,b\,\pi}{2}$ no longer holds.

A. Fredk. Harris, A.I.E.E.

Aluminium.

Your "Notes," page 145, in to-day's issue state:—The British Aluminium Company's plant of 2,500 H.P. (twenty-five hundred), is double the Pittsburgh Reduction Company's plant of only 1,450 H.P. (fourteen hundred and fifty).

This is erroneous, and my statement can be verified by reference to *Cassier's* "Niagara Number," July, 1895, page 334; and Dr. S. P. Thompson's 1896 edition, "Dynamo-Electric Machinery," page 731.

Against the British Company's 2,500 H.P., the Pittsburgh Company has *ten thousand* H.P. now at work; steam plant, 2,000 H.P., started 1888, still running. Two plants at Niagara, 2,100 H.P., started August, 1895, and 4,500 H.P., started spring, 1896, besides later additions.

T. Stevens, E.M., A.I.E.E.

January 29th, 1897.

To Prevent Misunderstanding.

I notice in your issue of to-day you insert a paragraph on page 135 respecting the winding up of this company. As your notice may mislead a good many of your readers into thinking that the company has ceased to exist, I beg to inform you that such is not the case, but that the company went into liquidation for the purpose of reconstruction, for private reasons, in August 1895, and the meeting which you notice is called in pursuance of Board of Trade regulations as the final action in the reconstruction of the company.

Hoping you will give this due notice so that no misunderstanding may arise amongst many of the company's clients, who are no doubt your readers,

For The Keighley Electrical Engineering Company, Ltd.

A. D. Smith.

January 29th, 1897.

Mechanical Theory of Electricity and Chemical Action.

Just a word of addition to my letter of last week. It may be argued that if iron is brought into the field the M of the first term is increased without increasing the second. If however, we increase the self-induction by a change in the form of the circuit the M's are identical, and my objection is valid. In any case, R contains as a factor the self-induction of the circuit when free from iron—which is absurd.

H. C. Haycraft.

January 29th, 1897.

In reply to Mr. Haycraft, the hypothesis of variable ether density ought not to be abandoned till experiment has proved it to be wrong, and not then if a theory based on it is capable of suggesting new experiments which may lead to new facts. Proceeding along a circular line of force round a wire the ether density gradually increases, and on passing through the plane of the circuit it suddenly diminishes, and we arrive at the place we started from. Instead of talking about porcupines, Mr. Haycraft would do better to refer me to some experiment in which the field inside a circular solenoid has been carefully mapped out. I thought my hypothesis gave a clear idea of what Hertzian radiation was, but I cannot deduce from it, as Mr. Haycraft appears to have done, that a Leyden jar discharged round a solenoid would give "ether sound waves propagated axially" and "incapable of polarisation," whatever they may be. I admit that it was a mistake to call k the specific inductive capacity of the medium.

I nowhere assume that the loss of angular energy in a collision is independent of ω, in fact, I was very careful to say that the angular velocity was brought up to ω again after each collision. The quantity, n, depends on the linear velocity of the molecules, on their size, and on their closeness together, and obviously does not depend on any rotation they may have.

As regards M in equation (1), Mr. Haycraft should read more carefully, and he would see that the M in the first term is not the same as the M in the second when there are magnetic substances in the field. Equation (1) is for a circuit with no iron in the field. The statement about an apparent reversion to a corpuscular theory of light is mere verbiage.

Mr. Haycraft might well have called attention to the par about the plate-glass electrical machine; this was hurriedly written and is obviously all wrong.

Arthur Whitwell.

February 1st, 1897.

The Amazon Cable.

The article referred to by A. E. would be better described as retrospective than critical, as such can only be its object at the present time and until the difficulties discussed and agreed upon by both A. E. and myself have been overcome. Its object was to bring events to date from the time of the writing of the City Notes on July 12th, 1895.

The laying of the cable further in on the banks will not, I think, eliminate all dangers, and to effect this operation and to avoid the mouths of tributary rivers, "crossings" will have to be made, the choice of place for which will require great care. Mud in tropical rivers is oftentimes also of a treacherous nature, and cables embedded in it are at times irrecoverable and necessitate a great expenditure during repairs.

There can be no other desire than that of success to any company undertaking pioneer undertakings, and, having started well and in the 5 per cent. results worked out upon returns given to the present period a close regard to deductions was not made. Whatever increase of traffic which may have been due to enthusiasm consequent on the laying of a new cable has been given to the company, and the calculations were based upon the working of the lines throughout the year without interruption. On the other hand, a trade report put together for the Columbian Exposition at Chicago in 1893, shows remarkable development and growth of the public revenue in, and of exports from the Amazon State up to that year.

The development of shipping at Manaos, said to be from 45,600 tons in 1872-73 to 566,800 tons in 1891, is undoubtedly great, and it may be that the capital of the State of Amazon is destined, by reason of its central position in the Amazon valley, to become the emporium of innumerable water routes, but this I think should be left, as well as the result of the engineering difficulties for the future to decide, as neither, I imagine, can be positively determined at the present moment.

If the last paragraph of your correspondent is correct, and it is not doubted, I think it will be a great relief when the difficulties to be encountered are upon something less than 400 miles, or over 30 per cent. of the whole length of the line.

The Writer of the Article.

Extraordinary List of Tenders.

We notice the comments made by you under the heading "An Extraordinary List of Tenders," in your issue dated January 29th, and beg to inform you we were in no wise desirous of cutting prices. A mistake was made by us in looking through the specification, which was not altogether inexcusable on our part, and have written to the Portsea Island Union authorities on January 26th, stating the discovery of our error and asking to withdraw our tender.

We shall be glad if you can find space for this explanation of an obvious mistake and oblige.

For New & Mayne, Ltd.
J. D. Manley,
Manager Contracting Department.

Wiring Tenders.

In reference to the "Comparative" note of tender, published in the Electrical Review of January 29th, and evidently directed against ourselves, we beg to offer the following remarks:—

Taking in order the three buildings referred to, it is sufficient to state in regard to

1. *No.* 30, *Portland Place.*—The estimate of £84 was for three less only than double the number of points, and one less only than double the number of lights, covered by our estimate of £35.

2. *Hereford House.*—The estimate of £70 10s. was for three points and four lights, more than double the number provided for in our specification.

3. *Prince's Gardens.*—In this case not only is there a similar disparity between the amount of work covered by the specification, but the figures given as our estimate are quite incorrect.

The above facts are a sufficient reply so far as figures are concerned, but no such unwarrantable suggestion of inefficiency should have been made by anyone, without an inspection of the work. The only portion of the work referred to which is complete, is that at Hereford House, and in regard to quality of material, we might say that the wire used was of Silvertown and Siemens manufacture, and that the workmanship was also of the best class.

Eastlakes, Limited,
E. S.

[We said "Efficiently and profitably."—Eds. Elec. Rev.]

Correspondence.—We regret that the crowded state of our columns this week compels us to hold over a communication from Mr. Willoughby Smith on "Communication between Coast and Lightships," and several others on various subjects, until next week.

BUSINESS NOTICES, &c.

Amalgamation.—We have before us a circular stating that the Horsfall Refuse Furnace Company, Limited, and the Loidis Engineering Syndicate, Limited, have amalgamated under the title of the Horsfall Furnace Syndicate, Limited. The Syndicate takes over the whole of the assets and liabilities of the two old companies. The nominal capital is £50,000. The manager and secretary is Mr. Frank L. Watson, A.M.I.C.E., and the registered office is at Athenæum Buildings, Park Lane, Leeds.

An Electrial Exhibition.—An electrical engineering exhibition is to be held at Riva, on Lake Garda, Austria, from May to October next.

Electrical Wares Exported.

Week Ending Jan. 26th, 1896.	£	s.
Alexandria	10	0
Algoa Bay	79	0
Amsterdam	15	0
Bangkok	500	0
Boca	67	0
Bombay	41	0
Brisbane	153	0
Buenos Ayres	104	0
Calcutta	119	0
Cape Town	517	0
„ Teleg. mat.	937	0
Carthagena	32	0
Coolgardie	117	0
Demerara	5	0
East London	347	0
Hong Kong. Teleg. mat.	89	0
Liban	16	0
Melbourne	186	0
Orotava	10	0
Port Natal	34	0
Singapore	14	0
Sydney	159	0
Total	£3,551	0

Week Ending Jan. 26th, 1897.	£	s.
Alexandria	372	0
Albany	397	0
Amsterdam	125	0
Antwerp	150	0
Bangkok. Teleg. cable	120	0
Bombay	50	0
Buenos Ayres	488	0
„ Teleg. mtl.	73	0
Calcutta	454	0
Callao. Electric lighting cable	768	0
Cape Town	368	0
Colombo	50	0
Durban	143	0
And 187 tons telegraph material.		
East London	147	0
Flushing	38	0
Hiogo	503	0
La Treport	10	0
Madras	14	0
Melbourne	92	0
Perth	165	0
Port Elizabeth	25	0
Reval	72	0
„ Teleg. mtl. ...	80	0
Rosario	108	0
Santos. Teleg. mat. ...	592	0
Sydney	573	0
Valparaiso. Teleg. mat.	145	0
Yokohama	535	0
Total	£6,661	0

Foreign Goods Transhipped.

	£	s.
Boulogne. Telephone ...	20	0
Hamburg. Elec. lamp ...	20	0
„ Teleph. mtl.	27	0
Hong Kong	150	0
Sydney	34	0
Total	£251	0

	£	s.
Port Elizabeth. Teleph. material	143	0
Total	£143	0

Announcement.—Mr. S. Thomas Pemberton, M.I.E.E., begs to inform us that he has severed his connection with Messrs. B. Bridgwater & Co., City Ironworks, London, E.C., and is now acting as representative engineer for the Blackman Ventilating Company, Limited, in Scotland.

Brussels Exhibition.—It is reported that the prospects of British representation at this exhibition are satisfactory. It is understood that there will be a fine exhibit associated with electric traction.

Contradiction.—Messrs. Gent & Co., of Leicester, write as follows:—"A paragraph recently appeared in a trade journal that a Mr. Gent, who has started in our line with a partner, is son of the head of our firm. As there is no one of that name in the firm, and has not been for over two years, this is an evident mis-statement, made, no doubt, to reap some benefit from our reputation, and we trust you will find room to contradict the announcement. Our late partner, when retiring, left us in the dissolution agreement the sole right, as far as he could, to the name of Gent, either alone or combined with any other, besides binding himself not to compete or help anyone else to do so."

Dissolutions of Partnerships.—Messrs. Sidney Sharp, J. M. V. Money-Kent, E. Jesse Piper, lately carrying on business as Sharp & Kent, at 34, Victoria Street, Westminster, and other addresses in London and Liverpool, notify in the *London Gazette* that they have dissolved partnership by mutual consent as from January 25th. The business will be continued by the said E. J. Piper under the style of Messrs. Sharp and Piper.

Messrs. S. I. Pettitt and L. A. Hards, lately carrying on business under the style of Pettitt and Hards, electrical engineers, at 2, Duke Street, Adelphi, London, have dissolved partnership by mutual consent. Debts will be attended to by S. I. Pettitt, who will continue the business under the style of Pettitt & Co.

Electric Clocks.—Edinburgh is following the lead of one or two other Scotch towns, and is going in for electrically controlled public clocks.

Electricity in Tinplate Works.—Messrs. Herbert Lewis and Fletcher, of Cardiff, have on hand the lighting of Maesteg Tinplate Works, Maesteg.

Elmore Copper.—We are informed that the Admiralty have placed Elmore's Patent Copper Depositing Company, Limited, on the list of firms who may tender for the supply of copper tubes and sheets to H.M dockyards.

Electrical Engineering in Russia.—Messrs. Duflon and Konstantinourtch, of St. Petersburg, the Russian agents of Messrs. Soutter, Harlé and Co., of Paris, have lately established electrical engineering works of their own, giving employment to about 250 persons.

Gas.—At the armour plate works of Messrs. Vickers, Sons and Co., Sheffield, last week, a gas explosion wrecked an engine house, killing one man and injuring seven others.

On Sunday morning two men were found dead in bed at Drogheda through gas suffocation, there being an extensive leak in the room. Five others were on Sunday lying at the local hospital in an unconscious state from the same cause.

Last week a gas explosion occurred at Victor Street, Stone. An escape was sought with a naked light.

At Glastonbury, on the 27th ult., a Park Terrace residence was wrecked by a gas explosion.

The disastrous fire which occurred at a Shoe Lane, E.C., warehouse on Monday night, is supposed, says the *Times*, to have been preceded by an explosion of gas.

Liquidation Notices.—In a *London Gazette* notice it is stated that a meeting of Taylor's Smokeless Boiler Syndicate, Limited, will be held at the office of Messrs. Gadwell & Co., solicitors, 16, Cook Street, Liverpool, on Friday, March 5th, at 11 o'clock, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted and the property disposed of, and conducting business usual at such meetings.

In the same publication is announced a general meeting of the Pure Carbon Company, Limited, at 11 o'clock on Thursday, March 4th, at 57, Moorgate Street, E.C. for a similar purpose.

Mr. Slater Lewis's New Book.—We are pleased to hear that Mr. Slater Lewis's new book on the "Commercial Organisation of Factories" is meeting with a large sale. We are also glad to hear that Mr. Lewis's system has just been adopted by one of our leading engineering firms employing over 1,000 hands, and that several others are already contemplating its introduction into their works.

Petroleum Engines.—From the Britannia Company, of Colchester, we have received a list of their petroleum oil engines (Gibbon's patent facile).

Release of Trustee.—It is officially announced that Mr. Thomas England, of Halifax, Official Receiver, has been released, as from January 4th, from the office of trustee in *re* Chas. F. Fox, electrical engineer and contractor, &c.

Smoking Concert.—The staff and employés of Messrs. Marryat, Lillywhite & Co. held their first smoking concert at the Sessions House Hotel, Clerkenwell, on Monday, the 1st inst. The next concert is fixed for Saturday, April 24th. Mr. W. Mills is the hon. sec.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The residents in St. Nicholas Street, being impressed with the benefit that George Street tradesmen derive from the public electric arc lamps, are memorialising the Council, asking that their thoroughfare may be similarly lighted.

Bournemouth.—The Council, in committee, have considered a letter from the Bournemouth and District Electric Supply Company, giving the terms on which they would be prepared to sell their undertaking to the Council. A proposal "That a committee be appointed, with power to obtain any assistance they may require, to consider the question of purchase and report to the Council," was put and lost. Eventually the Council, by a majority, agreed to the following resolution: "That a reply be sent that the Council are not prepared at present to entertain the proposal of the company."

Cardiff.—A sub-committee is to consider the question of taking into the Electric Lighting Committee's own hands the collection of electric lighting rents, which now amount to £5,700 per annum. The electrical engineer says that clerical assistance in the office is also needed.

Chelmsford.—The Lighting Committee reported, on 27th ult., that Messrs. Crompton & Co.'s account for the public lighting of the town by electricity for the quarter ending December 25th was £252 2s. 6d. The Committee had deducted 10s. 10d. for fines for lamps which had not been lighted, and they recommended the payment of the balance. This was agreed to. A Committee is to inquire as to whether the Town Council has any control over the Chelmsford Electric Lighting Company as regarded their private lighting.

Cirencester.—The District Council has referred to the General Purposes Committee a letter from Messrs. Eastlakes, Limited, who asked whether the Council would give support to an electric lighting scheme if an installation were put down.

Croydon.—On Sunday, the Parish Church was lighted for the first time by electricity.

Edinburgh.—When a proposal to supply Portobello with the electric light came before the Cleaning and Lighting Committee on 1st inst., a sub-committee was appointed to consider the subject of the extension of the electric light system to other thoroughfares of the city, and with a view to resolving upon a definite policy, the Committee was asked to fix the sum required for expenditure for the year from May 15th next.

Exeter.—The financial prospects of the electric lighting undertaking acquired by the Corporation are encouraging. At a meeting of the Council last week the Town Clerk stated that, taking the past six months, the Council had had liabilities of about £900 on the electric lighting undertaking, and receipts of £1,800. The liabilities did not include interest, but there was plenty of margin.

Factory Lighting.—Messrs. Roberts & Edwards, of Berwyn Mills, Glynceiriog, have adopted electricity as the lighting power in their factory.

Frensham.—The country mansion of Mr. R. H. Combe at Pierrepont is being fitted up for electric lighting, and Frensham Place also is to be similarly lighted for Mr. C. A. Pearson.

Glasgow.—A meeting of joint sub-committees has unanimously agreed that all the existing electric lamps should take the form of pendant globes, similar to those recently erected at Charing Cross, where the illumination had been greatly improved.

Halifax.—Alderman Woodhead, at the last meeting of the Council, said there had been a very great increase in the demands upon the Corporation installation in 1896. In 1895 they supplied 95,000 units, and in 1896, 154,000, an increase of nearly 65 per cent. It was said that the consumption by the Corporation was chiefly responsible for this increase, but as a matter of fact, the Corporation had only consumed 20 per cent. The increased supply to the public was therefore over 45 per cent.

Hospital Lighting.—At the Port Sanitary and Hospitals Committee of the Corporation, on 28th ult., it was agreed that the new extension of the Netherfield Road Hospital should be lighted by electricity; that tenders should be invited from outside firms, and that the work be not done by the Corporation. This motion will need the approval of the Liverpool City Council.

Leicester.—Last week a report was presented by the Gas and Electric Lighting Committee, which stated that the total output of electric current from the central station for the half-year ending December 31st last was 147,421 Board of Trade units. The number of consumers was 251. During the half-year the cables had been extended into the Newarke. The committee had determined to reduce the price from 6d. to 5½. per Board of Trade unit. Alderman Lennard, in moving the adoption of the report, said the output was more than double the amount for the same period in 1895. In the second half of 1895 the amount was 66,916 units, and in the first half of 1896 it was 90,786 units, while the number of consumers had increased from 157 to 251. The balance-sheet had not yet been got out, but he believed it would be found that they had made a profit in 1896—at any rate, if there had not been a profit, the loss would be infinitesimal. The report was adopted.

London, E.C.—At the last meeting of the Commissioners of Sewers, Mr. Brooke Hitching asked the chairman: (1) If the contract between the Commission and the City of London Electric Lighting Company for the full lighting of the City was yet completed; if not, when it probably would be completed. (2) Whether the Commission was precluded from purchasing absolutely the company's undertaking only 21 years after the completion of the contract. (3) Whether the Commission would raise any objection to the granting of a provisional order by the Board of Trade to a rival undertaking, the price of the current in the City being the highest charged in the County of London for private lighting, and which might be reduced from 8d. to 5d. per unit, as in the case of St. Pancras, by healthy competition. Mr. Turner said the answer to the second question was "Yes," and the answer to the first was that the contract was complete. As to the question of the 21 years, the contract was not complete, as the lighting of the minor streets had not been decided upon, and the 21 years would not commence to run until it was. With regard to the third question, the Commission, so far as it had the power, had given exclusive right to the company to open the streets of the City.

Mile End.—The Guardians recently invited revised tenders for the electric lighting of their premises. The tenders submitted ranged from £3,456 to £5,374, and will be considered by the whole board in Committee. They are as follows:—

	£	s.
Sussex Electrical Company	3,456	0
A. L. Fyfe	4,137	10
Holmes, J. H. & Co.	4,316	0
Brush Electrical Engineering Company	4,329	16
J. Richmond & Co.	4,400	0
The Thames Ironworks Company	4,926	0
Joel & Co.	4,972	0
Electrical Engineering Corporation	5,999	0
Laing, Wharton & Down	5,374	1

Nuneaton.—The District Council has given the Nuneaton Electric Light Company permission to attach their cables to the chimney of the Town Hall.

Peterboro'.—The Lighting Committee has received a letter from Messrs. Edmundson, Limited, stating terms on which they would be willing to take over the powers of the Corporation with respect to electric lighting.

Rochdale.—A sub-committee of the Gas Committee is to inquire into the electric lighting question, and advise whether the Council shall apply for a provisional order.

Somerset House Lighting.—We understand that Somerset House is to be lighted throughout by electricity, the installation, involving a total expenditure of £8,000, having been sanctioned by the Treasury. The estimates of 1897-8 will provide for a payment on account of £2,500 for that portion of the work scheduled for completion by the end of the next financial year.

Spain.—A central station is in course of erection at Caceres. The motive power will consist of Crossley gas engines, Dowson gas plant being installed. A company has just been formed with a capital of £4,000, to be known as the Sociedad Anonima Electrat de Daimiel, to establish a small central station at Daimiel.

Sunderland.—The Electric Lighting Sub-Committee have issued an estimate for the half-year ending September 30th next. The estimated expenditure is £1,066 5s. 3d., and the estimated revenue £1,053 7s. 4d., leaving an estimated deficit on the half-year's working of £12 17s. 11d. In the corresponding half of last year there was a deficiency of £89 0s. 6d., while for the current half-year it is estimated that the gross profit will be £1,283 0s. 7d.

St. Helen's.—The Electric Lighting Sub-Committee have decided that the supply of electric light to private consumers shall be from 6 a.m. to 9 a.m., and from three in the afternoon to midnight. Test-room instruments, at a cost not to exceed £50, are to be purchased. It has been resolved to extend the mains 60 yards along Bridge Street.

Teignmouth.—The Surveyor is to make inquiries as to cost, &c., of lighting the main roads by electricity.

Tunbridge Wells.—The Lighting Committee reports that the total estimates for the electric light station, cables, lamps, &c., will be £1,500 for the next 12 months, and power is to be sought from the Local Government Board to borrow another £15,000 for the extension.

Wandsworth.—On Thursday last week, at the Middlesex County Council, a lengthy discussion ensued upon a report of the Asylums Council, which recommended that gas should be replaced by the installation of the electric light at the County Asylum at Wandsworth, at a cost of £5,000, and stated that last year 7,648,200 cubic feet of gas was consumed, at 2s. 4d. per thousand, and that the extension of the Asylum would mean an increased consumption of gas, making the total about 12,000,000 feet. They had consulted Mr. W. H. Massey, of Queen Anne's Gate, and as a result, it was believed that the cost would be about 1s. 6d. per 1,000 feet of gas; the present boiler power would be enough for 750 lights. It was stated that it was expected a great saving would result. An amendment having been withdrawn, the motion was carried.

Wallasey.—The municipal electric lighting works were opened on 29th at Wallasey, which is sometimes called the "Brighton of the North." We hope its electric lighting plant will be as successful as the Brighton of the South has been.

The borough electrical engineers of a number of other towns in that part of the country, and a number of gentlemen representing the contractors and others interested, were present at the switching-on ceremony, which was performed by Mr. Ellery, the chairman of the District Council. Mr. J. H. Crowther is the gas, water and electrical engineer, and Mr. J. A. Crowther assistant electrical engineer.

West Ham.—Only one tender was submitted for boilers required for the electric lighting works. This was sent by Messrs. Spurr, Inman & Co. The Borough engineer's approximate estimate was £5,130. The Highways Committee has power to act in the matter.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bristol.—The formal inspection of the Eastville extension, by Major Cardew on behalf of the Board of Trade, took place on 29th ult. A special car conveyed the party over the line, and subsequently an inspection was made of the arrangements at the St. George's power station for dealing with the additional traffic. Major Cardew expressed himself as thoroughly satisfied with the whole of the electrical arrangements, and the company on Monday opened, without public ceremony, the line between Old Market Street and Eastville for working by electricity. The authority to convert the Eastville section of the line from horse-power to electric traction was only obtained in July last, so that the whole of the works, including the relaying of the tramway and the cables and the electrical equipment, indoors and outdoors, has been completed within six months. The opening of this section means the discarding of about 50 more horses, which were announced for sale yesterday. After the early morning cars running frequently until 8 o'clock, the cars on the new section run every six minutes till 10.30 p.m. The distance of 1¼ mile is done in about 13 minutes from Old Market to Eastville.

Coventry.—The Tramway Company's Bill for the extension of their line received the consent of the Coventry Corporation on Tuesday, subject to an undertaking being given that the company agree to certain restrictions imposed by the Corporation. The only point raised was the keeping of the permanent way in repair, which it was understood the company would thoroughly carry out. At the meeting of the Warwickshire County Council, through whose area a part of the line will run, a committee was appointed to oppose the Bill if necessary.

Glasgow.—The electric traction scheme still hangs fire. The Corporation Tramways Committee, on 27th ult., agreed to let Mr. Young's report recommending the electric trolley system lie on the table in the meantime.

Dover.—A recommendation of the Tramway Committee, regarding the proposed supply of current by the Electricity Supply Company for working the Council's tramways, was before the Council last week. Alderman Adcock, on behalf of the Committee, placed one or two facts before the Council with respect to the agreement which had been arrived at with the company. The Committee had discussed the matter well with the company, and had arrived at an agreement which they felt they could recommend the Council to accept. In the first place, the company asked a very much larger sum than they had now consented to take. The company asked 3½d. per tram mile, but had now agreed to accept 3d. per unit up to 240,000 units yearly. The consulting engineer thought they would do better to take the electricity by units, rather than by tram miles. He had been of opinion that the Electricity Company could supply the power for the trams with the apparatus they had in use for lighting the town; but that was not so. The trams would not be running in the early morning, and at night, when it was necessary to light the town, and in order to supply the requisite power, the company would have to incur an expenditure of £8,000 for fresh plant. Mr. Sellon, the consulting engineer, had estimated that if the Council put down their own plant to supply at 2¾d. per unit, the cost would be £12,000, without reckoning for land. The Council had power to take over the electric lighting works in about 17 years, and if they constructed a power house of their own now, they would have two establishments on their hands. The tramway contract with the company would run concurrently with the electric lighting contract, terminating in 1914. A clause had been inserted in the agreement that in the event of coal being produced near Dover at a cheaper cost, the company would reduce their charge. Subsequent speakers elicited the fact that the minimum number of units per annum is to be 160,000. The cars will run every 10 minutes from Buckland and the Pier, and every hour from Maxton.

The recommendations were agreed to by the Council.

We mentioned last week that some of the tenderers had made errors in their estimates. The Tramway Committee reported again on the matter as follows:—

"Rails.—Letters and telegrams from Messrs. Dick, Kerr & Co., state that in consequence of considerable orders having been booked since their tender was made, they are unable to give delivery of the rails as stipulated and to maintain the price of their tender, but ultimately agreeing to supply half the quantity by March 10th, and the balance during the first few days in April, if an addition of £250 is made to their tender, making the total £5,558 4s. On the advice of the surveyor and consulting engineer, the committee recommend that these terms be agreed to."

In the discussion respecting this matter, it was stated that no other firm could furnish the Chicago bond, and the surveyor thought this was the best rail possible, and well worth the amount.

The recommendation was agreed to.

Norwich.—The Norwich Electric Tramways Bill came up on Wednesday last week for proof of compliance with the standing orders. A number of allegations of non-compliance with the standing orders were made, the memorialists complaining, among other things, that the widths of roads were not properly stated on the plans. The Bill proposed that Section 43 of the Tramway Act, 1870, which gave local authorities power to acquire the tramway undertaking after 21 years, should not apply to the company, and Mr. Pritchard thought that inasmuch as the Bill extended the time limited by that within which local authorities could purchase, it should contain a clause providing for such purchase. There was no such clause in the Bill, and consequently the public might be misled. Mr. Kennedy contended that the Bill gave power, not only to alter, but to repeal the section of the 1870 Act, and therefore there was no necessity for a clause as suggested. This view, says the *Norfolk Weekly Standard*, was taken by the Examiner, and the allegation was disallowed. Some minor objections having been put aside, the matter was adjourned.

Underground Railways.—The directors of the Metropolitan District Railway Company, in their recent report to the shareholders, state:—"Another very important Bill has been lodged by the directors themselves for authorising two additional lines between Earl's Court and Mansion House, at a deep level, immediately under the existing lines; and for adapting a portion of the railway to working by electrical traction, and so removing the serious prejudice to the traffic resulting from the heated atmosphere prevailing during the warmer months of the summer and autumn. The financial considerations involved in this Bill are, of course, much more serious than in the case of the other group of Bills. The subject of a deep level line or other improvement of the access into London, though not new, has quite recently been revived and urged upon the board by a combination of shareholders largely interested in the ordinary stock of the company, and in order that this important question should be dealt with in a business fashion, and its practicability rest upon engineering authority, the board has concurred in the necessary preliminary measures being taken, with a result that a Bill is lodged for effecting it if the company in special meeting so determine."

Volk's Electric Railway.—No time was lost in repairing the damage caused by the great storm to Volk's electric railway at Brighton, and the cars have resumed running every five minutes between the Aquarium and Paston Place.

TELEGRAPH AND TELEPHONE NOTES.

Melbourne Telephones.—Mr. John Hesketh, electrical engineer to the Queensland Government has been requested to investigate the Melbourne telephone system and report. This is the result of a recent enquiry into the efficiency of the telephone system in Victoria.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Maranham-Ceará	Dec. 2nd, 1896 ...	Feb. 4th, 1897.
St. Croix-Trinidad	Nov. 30th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	...
Grenada-Trinidad	Feb. 4th, 1897 ...	...
Delay to Trinidad and Demarara 12 to 15 hours.		
Landlines.		
Pernambuco-Ceara	Feb. 4th, 1897 ...	...
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Salisbury-Umtali	July 11th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok	Feb. 2nd, 1897 ...	Feb. 3rd, 1897.

February 1st.—The Argentine Republic are about to close the offices of the Compania Telegrafica del Rio de la Plata to international traffic.

February 2nd.—Until further notice telegrams for Brazil cannot be sent *viâ* Galveston and Key West. This affects all North Atlantic telegraph companies.

February 2nd.—Telegrams for San José, Guatemala, and places beyond are subject to censure.

Cable Ship Items.—H.M.T.S. *Monarch* left the river on Thursday, January 14th, to effect repairs to the *Kentish Knock* lightship electric cable. She arrived at her moorings off the Government dockyard, at Woolwich, at about 1 o'clock on Tuesday. We learn that the vessel had not been successful in effecting repair to the *Kentish Knock* lightship cable, bad weather having prevailed during the 19 days she has been away. We also hear that all the lightship cables are down—the *Kentish Knock*, the *Goodwin*, the *Hasbro'*, and the *Shipwash*. At the *Kentish Knock* it was found impossible to get the swivel up above water to reeve the cable through. All attempts to repair these cables are apparently to be abandoned for the present. The *Monarch* was to leave the Thames again on Wednesday or Thursday for the south somewhere, we could not learn precisely where. The only lightship now with electric communication appears to be the *Formby*, in Liverpool Bay. This was established in October 1895, and is about 4 miles in length, places the lightvessel in telephonic communication with Crosby lighthouse, and thence to the lifeboat station and Liverpool.

H.M.T.S. *Alert* is at present, or has recently been, we understand, in the Thames Ironworks Company's dry dock undergoing extensive repairs. This vessel, formerly the *Lady Carmichael*, was the property of the old Submarine Telegraph Company, and was built at Dumbarton in 1871, being now 26 years old, her tonnage is 369 tons gross, 194 tons net; length, 163 feet; breadth, 25 feet 3 inches; depth, 12 feet; built of iron, propelled by paddles. Consumption of coal is, we believe, from 20 to 25 tons per day; her bunker capacity is but enough for two to three days' steaming, and speed attainable probably does not exceed eight knots per hour. This steamer is but little more than a tug boat, which she closely resembles in appearance, an almost obsolete, antiquated craft in comparison with vessels as now constructed to carry out work of cable repairing. The space on board is utterly inadequate either for coal or cable. When the late Mr. John Bordeaux was superintendent for the old company he used to complain that often, owing to limited coal capacity and large consumption they would be compelled to run for port when a repair job had been nearly completed, and then be probably delayed by bad weather. The renewals now being carried out on this boat consist of a considerable length of plating on the bottom, new decks, and new sponsons. It is not very long since she had new boilers, when £6,000 was expended on her, now it is believed that another £5,000 will be the amount of the "little bill"; these items added to the sum paid for this relic of old times would represent a substantial total.

For an additional ten or twelve thousand pounds a well equipped fast steamer of much greater tonnage could have been built, a vessel which could have relieved the *Monarch* of much work, thus economising in the right direction. Now the larger ship has to take on the duties of the smaller one at a greatly increased cost of course, while the latter is being patched up, and the day of an improved efficient repair ship indefinitely postponed.

The *Monarch* consumes from 14 to 15 tons of coal per day attaining on that a speed of certainly 11 knots, if not more. At 12 tons per day she was supposed to give a speed of 10 knots per hour. She carries 10 days coal with 600 tons of cable on board.

Telegraphic Communication with the West Indies.—In the House of Commons on Monday Mr. Tomlinson (Preston) asked the Secretary of State for the Colonies whether he could give an approximate date on which it is likely that the sanction of her Majesty's Government will be given to the construction of a cable giving telegraphic communication with the West Indies which shall be under British control; was he aware that a cable of three words from Antigua to Great Britain costs at the present reduced rates 19s.; and was he aware that, while the Colonial Office are considering the question, the French and American lines are being pushed forward, and that when completed they will tap the principal sources of revenue, which would otherwise be secured to British enterprise? Mr. Chamberlain: I cannot state the date at which an agreement for the construction of the cable referred to will be completed.

Negotiations on the subject are in progress. A cable telegram of three words to Antigua costs 22s. 3d. A French cable has recently been laid by a French company in conjunction, as I understand, with an American company, which will compete for the West Indian traffic with the proposed British cable. I imagine this cable would have been laid in any case. General Laurie (Pembroke and Haverfordwest) asked if the right hon. gentleman was aware that both the Canadian Government and one or more of the West India minor governments were so anxious that this cable should be constructed, that that they had already voted or arranged for, subsidies to be granted for the purpose. Mr. Chamberlain: I think if the hon. and gallant gentleman requires precise and definite information he should put his question on the paper.

Sir George Baden-Powell asked the Secretary to the Treasury in the Commons last week whether in view of the benefits which such a connection would confer on the development of our West Indian Colonies, Her Majesty's Government have come to any conclusion with reference to the continuation to the British West Indian Colonies of the telegraphic cable communication from Halifax to Bermuda. Mr. Chamberlain informed Sir G. Baden-Powell that the attention of the Government was still directed to the continuation to the British West Indian Colonies of the telegraphic cable from Halifax to Bermuda in view of the benefits which such a connection would confer on the development of the West Indian Colonies.

The Pacific Cable.—In the House of Commons last week, in reply to Sir G. Baden-Powell (Liverpool, Kirkdale), who asked whether the conference on the telegraph cable to connect the Canadian Dominion with the Australasian colonies had concluded its labours, Mr. Chamberlain said,—The Committee has made its report, but as that report will be the subject of confidential discussions between Her Majesty's Government and the representatives of the Colonial Governments, no data can at present be given for its presentation to Parliament.

CONTRACTS OPEN AND CLOSED.

OPEN.

Boston.—February 8th. The Harbour Trust are prepared to receive tenders for an installation of electric light at the Harbour and Docks, Boston, Lincolnshire, consisting of steam engine, dynamo, switchboard, arc lamps and posts, mains, wiring, fittings, &c.

Derby.—February 6th. The Corporation wants tenders for the wiring and supply of fittings for electric lighting of the Derby Technical College. Specifications, &c., from Mr. J. E. Stewart, the electrical engineer.

Fareham.—February 15th. The District Council want tenders for cables and conduits, for excavation, making good, and sundry house and public lamp connections. Consulting engineers, Messrs. Kincaid, Waller, & Manville.

France.—February 27th. The Seine Prefectural Authorities in Paris are inviting tenders for the concession for the electric lighting of the Broca Hospital during a period of 10 years. Tenders to the Préfet de la Seine, Tribunal de Commerce, Paris.

Germany.—February 20th. Tenders are being invited by the Altona Direction of the Prussian State Railways for the supply of 4,000 incandescent lamps and 179,000 arc lamp carbons required during the financial year 1897-98. Tenders to the Königliche Eisenbahn Direction, Altona.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Poplar, E.—February 10th. The Board of Guardians want tenders for maintaining the electric bell system and telephone lines at the Workhouse, High Street. Particulars from Mr. Gilloch at the Workhouse.

Spain.—February 23rd. Tenders are being invited by the Municipal Authorities of Tarragona for the concession for the electric lighting of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Tarragona.

Wallasey.—February 18th. The District Council invites tenders for the supply and erection of a 200 kw. alternator with engine combined and for the requisite switchboard extensions. Particulars on application to the engineer, Mr. J. H. Crowther, the Great Float, near Birkenhead.

CLOSED.

Halifax.—The Electric Construction Company has secured the contract for the supply of an engine and dynamo for the electricity supply station at a cost of £3,610.

Lancaster.—The following tenders have been accepted by the Council:—Walter MacFarlane & Co., four electric arc lamp pillars and carriers; Drake & Gorham, five Jandus arc lamps.

NOTES.

Conversazione.—On Saturday, February 13th, the Birkbeck Students' Conversazione is to be held at the Institution, Bream's Buildings, Chancery Lane. Mr. Justice Bruce will hold a reception of guests from 7 to 7.30 p.m., and there will be a variety of entertainments and displays of exhibits. Two concerts are to be held in the theatre, the list of artistes including Miss Teresa Blamy, Mr. Bantock Pierpoint, Mr. T. E. Gatehouse (violin), Mr. Charles Fry and Miss Olive Kennett (recitals). There will be a dramatic entertainment, "Lady Fortune," a one-act comedy by Chas. Thomas, and selections will be played during the evening by the Æolian Ladies' Orchestra under the conductorship of Miss Rosabel Watson. Among the exhibits will be an art exhibition, a display of animated photographs in the Minor Hall, by A. Newman, Esq., and the latest Edison-Bell phonograph, shown by Mr. William Lynd. The buildings will be connected with places of amusement by means of the electrophone. Mr. J. Wimshurst will exhibit "The Wimshurst Electrical Influence Machine" at work, together with his new system for connecting the lightships with the shore stations. There will also be Röntgen "X" ray demonstrations and a Post Office telegraphic exhibit. In the Chemical and Experimental Physics and other departments popular lectures will be delivered.

The Pleasures of a Motor Car Trip.—We shall doubtless hear that the recent motor car race in the South of France was a remarkable success, and in anticipation of such statement, we may be pardoned mentioning a few of the happy incidents which occurred at various stages of the journey:—

Motor car No. 25 was the first to reach Nice. During the journey two cars came into collision, and were both damaged.

Another vehicle had only gone 5 kilometres, when it broke down.

While passing through Monte Carlo, one of the cars got beyond the control of its driver, and on pleasure bent, rushed into the Café de Paris. One of the iron pillars of the building was knocked down, and much commotion was caused among the customers.

Errata.—With reference to our first portion of the article on the Presidential Address last week, a correspondent writes pointing out that "Sandford Fleming is a C.M.G., but not a knight yet, though newspapers often so describe him. Sir Henry Mance was *quite* a junior in 1864, at the laying of the Persian Gulf cable, the chief assistants of Sir Charles Bright and Mr. Latimer Clark being J. C. Laws, F. C. Webb, and F. Lambert, Sir Charles Bright being in charge of the expedition to carry out the work according to arrangement with Colonel Patrick Stewart, R.E." The word "syphon," we may add, should have been spelt "siphon."

Lectures.—Mr. A. H. Fison, D.Sc., F.R.A.S., has been delivering a course of lectures on "Electricity and its Modern Appliances," at the Hampstead Vestry Hall.

Mr. F. B. Lyall, on 28th ult., lectured in St. John's Hall, Drumlithie, on the "Discovery and Development of Electricity."

On 25th ult., Monsignor Molloy lectured at the Dublin Catholic University, on the "Röntgen Rays."

Mr. Wm. Nicholl lectured on "The History and Development of the Electric Cinematograph," at the Ulster Minor Hall, on Wednesday last week.

City and Guilds of London Institute.—The Court of the Worshipful Company of Leathersellers, of which Dr. W. H. Perkin, F.R.S., is Master for the present year, have voted a grant of £150 a year to the City and Guilds of London Institute, in addition to their ordinary subscription, to be applied in founding one or more Fellowships, entitled "Leathersellers' Company's Research Fellowships," for the encouragement of higher research in chemistry in its relation to manufactures at the Institute's Central Technical College.

The Electric Lighting of Public Buildings.—In the Commons, on Monday, Mr. Massey Mainwaring asked if the National Gallery, the National Portrait Gallery, and the Natural History Museum could be lighted electrically. Mr. Hanbury, in reply, said if his hon. friend would look at Clause 1 of the Civil Service Estimates, he would see that it was proposed to ask Parliament to provide funds for this purpose.

Polarisation of the Electric Ray.—At the Royal Institution last Friday night, Prof. Jagadis Chunder Bose, of Presidency College, Calcutta, gave a lecture on "The Polarisation of the Electric Ray." Sir James Crichton-Browne was in the chair, and among those present were Lord Rayleigh, Sir F. Bramwell, Prof. Dewar, Prof. S. P. Thompson, Prof. Fleming, Prof. Armstrong, and Mr. A. Siemens. The lecturer, after a few introductory remarks, illustrating the nature of electric waves, proceeded, says the *Times* of Saturday last, to enumerate some of the conditions necessary for experimenting with them and to describe the exceedingly compact apparatus he had designed for the purpose. His generator produced the small sharp beam which alone could be utilised in experimental work, and he had succeeded in getting rid of the trouble experienced by Hertz in keeping in good working condition the balls between which the oscillatory discharge took place. The construction of an efficient detector had been more difficult. He had first used Prof. Lodge's coherer (consisting of a tube filled with iron filings), but found that, though delicate, it was very capricious, giving great sensitiveness one day and scarcely any the next. He, therefore, modified it, and made his receiver consist of a number of special springs, arranged evenly in a smooth ebonite case, and provided with a large number of contact points. He found that the efficient working of this receiver was determined very largely by the pressure on the spirals and by the strength of the current used. Its sensibility could be easily adjusted by altering the strength of the current. By means of this apparatus experiments in electric radiation could be carried on with as much certainty as could experiments with ordinary light. Prof. Bose then performed experiments illustrative of the number of properties possessed in common by light waves and electric waves. He exhibited the power of selective absorption to electric rays displayed by many substances, pointing out that while water, for example, which was a conductor, stopped them, liquid air, which was a bad conductor, was quite transparent to them. He showed they could be reflected from plane and curved mirrors, obeying the same laws as light. They could also be refracted, and he described an ingenious method, of which he also gave the optical counterpart, by which he had been able to calculate the index of refraction for certain opaque substances with considerable exactitude. In conclusion, he did a number of experiments with polarised electric rays. He showed that various crystals could polarise electric rays just as they did ordinary light, and proved that substances under pressure and strain could produce double refraction in them as did glass under the same conditions in light. Tourmaline was useless for electric rays, but a lock of human hair was extraordinarily efficient, and ordinary jute formed a good polariser. A book was a double-conducting structure which was a most perfect polariser, and a Bradshaw was far more effective as a selective absorption medium for electric radiation than was tourmaline for light.

A Big American Amalgamation.—There is a decided weakness in America for amalgamating electrical concerns. A few years ago, the monopoly of the General Electric Company of the States was opposed by many of the smaller undertakings, and a new opponent of that gigantic corporation came into the field in the form of the Siemens and Halske Electric Company of America. We now understand that the latter company has itself succumbed to the fashion, and proposes to consolidate with the Fort Wayne Electric Corporation, the joint capital stock being $6,500,000. Mr. R. T. McDonald, of the Fort Wayne Company, will be the leader in the new company, which will probably be known as the Siemens and Halske—Fort Wayne Electric Corporation.

Institution of Civil Engineers.—Yesterday, Thursday, the Students paid a visit to the Scientific Instrument Manufactory of Messrs. Elliott Bros., 101, St. Martin's Lane, W.C.

A Medical Electrician Wanted.—The London Homeopathic Hospital authorities are about to appoint a medical electrician, and applications for the post should be forwarded to the secretary-superintendent, Mr. G. A. Cross, not later than March 1st.

Electric Haulage in Collieries.—Before a recent joint meeting at Sheffield of the Midland Institute of Mining Engineers, and the Chesterfield and Midland Counties Institute, Mr. Jonathan Piggford read a paper on "Electric Haulage at Pleasley Colliery," where, he stated, electric haulage had been in use for six years as a substitute for horse haulage. Soon after its first partial and experimental adoption, the benefits of the new system became apparent, and up to the present time 48 horses have been withdrawn. Although, in the meantime, the output of the districts of the colliery which the horses formerly worked has increased five-fold, the cost of substituting and working by an electric haulage plant comes out at nearly 25 per cent. less. Mr. Longden, also of the Pleasley Colliery, was of opinion that Mr. Piggford had under-rated, rather than otherwise, the saving which had been effected by the change. Another speaker agreed that the electric system was the cheapest in the long run, while someone else said that the electric plant at his colliery was subject to frequent breakdowns, and there was a loss of 20 per cent. of the power on the cables and motor. Mr. Piggford, replying to the discussion, said he did not think the loss of power was so great, and breakdowns were certainly not so frequent where, as at Pleasley, the plant was not worked up to its maximum power. The chairman of the meeting said no doubt electric haulage was the haulage of the future, but he would warn all colliery managers to be very cautious indeed in adopting it.

Expert Testimony.—As Americans See Us.—A Chicago exchange, writing on the unreliability of expert testimony, quotes the case of the recent controversy at Bristol over the tramway question, and says that each side engaged the most noted scientists, and had apparently an invincible position until the other side was heard from. The Corporation engaged the services of Mr. W. H. Preece, C.B., F.R.S., and the tramway company, as our readers are all aware, employed Lord Kelvin and Dr. John Hopkinson. These men, says our contemporary, made reports, Mr. Preece's being naturally favourable to his clients, and that of the other eminent gentlemen wholly in favour of theirs. "So we have again expert testimony."

Dinner.—The technical staff of the Mount Pleasant Postal Telegraph Factory held their annual dinner, on Saturday last, at the Inns of Court Hotel, the chair being occupied by the superintendent of the factory, Mr. Martin F. Roberts, and the vice-chair by Mr. J. M. G. Trezise. During the evening a first-rate musical and dramatic performance was given with great spirit by members of the staff. Among the vistors present were Mr. J. W. Eames, Assistant Controller of the Central Telegraph Office; Dr. Mumford; Mr. Palgrave Simpson; Dr. Mullineux Walmsley, Principal of the Northampton Institute; Mr. Victor W. Morten, of the National Telephone Company; and Mr. P. E. Ridge, of the Office of Works. In proposing the health of "The Technical Staff," the chairman gave an interesting sketch of the manner in which the technical work had been carried on during the past 50 years, first at the old factory at Gloucester Road, Regent's Park, and then at the new factory at Mount Pleasant; and he also described the men who had at various periods constituted the technical staff. It is an interesting fact that some of the earliest experiments on covered wire for submarine cables were carried out at the old Glo'ster Road factory by Faraday.

To Kill or Cure.—Dr. D'Arsonval writes to a New York contemporary that he is a "great admirer of the bold work of the American electricians," and that he wants them to attack as their next problem for solution the cure of tuberculosis. He believes it to be well within possibility, and says truly that it is far more worthy of the effort of great philanthropists than electrocution. All, says the New York *Electrical Engineer*, will agree with him. Electrocution is a base method of employing a noble agent. To cure tuberculosis might well occupy the lifetime of the greatest electrical discoverer. There have been hints of a near approach to the goal named.

The Royal Society.—Among the papers read yesterday afternoon was one by Mr. M. Travers, on "Some Experiments on Helium."

The Man and the Hour!—For some time past it has been apparent that electric traction was receiving a certain share of public attention, and we have felt that the rehabilitation of the English tramway was near at hand. It has remained, however, for our contemporary, *The Senate*, to discover the individual to whom we must look in future as the head and front of tramway enterprise. It is a comfort to know that a gentleman exists who can so completely fill this difficult position—it is a pleasure to gaze upon the silhouette which accompanies his biography—it is our regret that we have so long remained in ignorance of his pre-eminent abilities. At all events, the time and the man have come, if we accept what *The Senate* says in its current issue, and we presume *The Senate* knows:—

> What Edison is to the electrical world, James Clifton Robinson is to tramways, and more—the man who knows all about it, the beginning and the end. For he is the one man in Europe who has at his finger ends the story of the tramway, having seen everything and all progress, from the "step rail" of George Francis Train's day, to the latest and most perfected development of mechanical and electric traction on the systems of the world.

Higher praise could no tramway man receive; but even *The Senate*—albeit, it voices its appreciation of Mr. Robinson's talents in somewhat fulsome terms—cannot yet fully determine his proper place among his fellow men. It says:—

> It is difficult, indeed, to know where to place Mr. Robinson, whether in the ranks of born geniuses, or among erudite beings. He would probably select neither, for we cannot "see ourselves as others see us," to use a well-known quotation. But perhaps it is as a genius that he scores best; but let it be either as a genius, or as an erudite being, his successes in life have been remarkable, nor has this been secured through the playfulness of sorry Dame Fortune, whose smiles often are deceitful, but through sheer hard work and the right application of a bountiful supply of natural energy. There has been no waste of strength or power with him.

To classify correctly is always difficult, but it cannot be often that a biographer is forced to hesitate between the horns of such a pleasing dilemma. Happy and favoured Mr. Robinson, upon whom Nature has so lavished her gifts that his "born genius" rivals his acquired erudition! May "The Doyen of Tramways" long live in the land—may his "ever open mind and ever exhaustless energy" solve the problems and advance the progress of electrical motive power—and may *The Senate* estimate of "the value attached to his opinion on all matters, administrative, financial, practical, and scientific, connected with tramways" be wholly endorsed by generations yet to come.

On Electrical Terms used by Physiologists.—Dr. Waller's explanation may justify the use of such terms as "zincative" and "zincable" as mnemonics for the private use of the student of electro-physiology, but to introduce them seriously into scientific terminology is likely to hinder research. The terminology of electrical science is not so meagre that it should be incapable of expressing the electrical conditions of protoplasm for which Dr. Waller has created those ugly ducklings "zincative" and "zincable." It is difficult to see the lines on which "zincative" is built; "talkative" is given to talking, therefore we suppose "zincative" must mean, given to "zincing."

> When the injured protoplasm goes a zincing,
> More or less, under anode or cathode,

might be used by Dr. Waller to briefly explain the Bernstein electrotonic decrement or the Hermann polarisation increment, if it did not suggest comic opera. But why not say, in orthodox language, that the electric potential of protoplasm is raised by injury, and the specific increase is greater under anodic influence and less under cathodic influence. Electricity has points of contact with many other sciences, but it has never yet been found necessary for any of these sciences to manufacture a special set of electrical terms for its own use.

The Northern Society of Electrical Engineers.—On Monday next, February 8th, 1897, a paper on "The Supply of Electricity at 230 Volts" will be read by Mr. A. H. Gibbings, of Bradford.

X Rays.—We understand that the position of the bullet in the body of Miss Waller, the actress, who was shot in the Marylebone tragedy, has been located by means of the X rays. It is lodged in the thorax.

Will.—The will has been proved of Admiral Sir Geo. Henry Richards, late managing director of the Telegraph Construction and Maintenance Company, the personal estate being valued at £34,726.

The Institution of Electrical Engineers.—On Thursday, February 11th, the discussion on Mr. Hollins's paper on "Electric Interlocking the Block and Mechanical Signals on Railways," will be continued.

On the Capacity and Residual Charge of Dielectrics as Affected by Temperature and Time.—The following is an abstract of a paper on this subject read before the Royal Society, January 28th, by Dr. J. Hopkinson and E. Wilson:—"The major portion of the experiments described in the paper have been made on window glass and ice. It is shown that for long times residual charge diminishes with rise of temperature in the case of glass, but for short times it increases both for glass and ice. The capacity of glass when measured for ordinary durations of time, such as $\frac{1}{100}$th to $\frac{1}{10}$th second, increases much with rise of temperature, but when measured for short periods, such as $1/10^6$ second, it does not sensibly increase. The difference is shown to be due to the residual charge which comes out between $\frac{1}{50000}$th second and $\frac{1}{100}$th second. The capacity of ice when measured for periods of $\frac{1}{100}$th to $\frac{1}{10}$th second increases both with rise of temperature, and with increase of time, its value is of the order of 80, but when measured for periods such as $1/10^6$ second, its value is less than 3. The difference again is due to residual charge coming out during short times. In the case of glass, conductivity has been observed at fairly high temperatures and after short times of electrification; it is found that the conductivity after $\frac{1}{50000}$th second electrification is much greater than after $\frac{1}{10000}$th, but for longer times is sensibly constant. Thus a continuity is shown between the conduction in dielectrics which exhibit residual charge and deviation from Maxwell's law and ordinary electrolytes.

Calcutta and Electric Tramways.—We have always been accustomed to think that this country was about the worst possible for enterprising traction engineers who desire to introduce new and more economical systems for operating tramways, but, from all advices, we have been no more difficult to move forward in England than they are in the East. Here at home the trouble has been to convert existing lines to electric traction, as being the best and cheapest, and until quite recently, when the Light Railways Act became law, there was practically no question of extensive systems of *new* tramways worked electrically. In Calcutta the same trouble has arisen. Effort after effort has been made to get powers for installing electric cars upon the tramways now existing, but so far the only result has been that the local authority is taking the matter into consideration—is practically "sitting upon it," like an old hen upon an addled egg. We have seen a great deal of this "sitting" business, and extend hearty sympathy to those in Calcutta who are striving hard to improve matters all round—for the public who use the cars and the shareholders who own them; but with Glasgow and Belfast in our mind's eye we cannot feel much astonishment that a municipal authority should require six months to make up its mind that it "wants information," even though all the necessary information for a body of common sense has long been given. Messrs. Kilburn & Co., of Calcutta, in conjunction with Messrs. Crompton & Co., Limited, on this side, have done all they possibly could to push the matter forward, making every necessary arrangement for carrying it through successfully, but six months of vacillation and ignorance on the part of the municipal commissioners have exhausted Messrs. Kilburn's patience, and the matter is now left for the Calcutta Tramways Company to pull through—if they can. We admire Messrs. Kilburn's enterprise, but not their lack of patience. Six months are as nothing to a municipal body, who may be considered a monument of inertia in both the senses of that word—desperately hard to stir into motion, and equally difficult to stop when set going. If it had been six *years*, now, we could have understood it, but *six months!* Try again, Messrs. Kilburn, Crompton & Co., and may good luck attend the brave!

The Retort Courteous.—Our American friends appear to have enjoyed our articles on "Steam Consuming Apparatus" and "Breezy Bristol" beyond our wildest dreams. Their pleasure has been akin to that of the hypochondriac whose only happy moments are those which he spends with his feet in hot water and mustard and a blister on his chest; he curses the mustard and howls under the blister, but his soul is wreathed in smiles as he revels in the prospect of returning health. We can assure our friends on the other side that our admiration of them and their works is only second to their own, and should the day ever come when their engines may compete with our home-made article, no one will more heartily than ourselves wish them success, provided that in the meantime they shall have taken down the barriers of the protective tariff of their childhood. It is very curious to note with what misplaced industry and ingenuity our friends labour through several columns in the discussion of our remarks from their own point of view; they flatter us by attributing the first article to our office boy, they tell us that whether we think so or not, the effect of electric traction on steam engines is really and truly very shocking; they suggest that we should complete our education by going over and seeing for ourselves. We should like nothing better, and we feel certain that over the loving cup we should shake hands and drown all sorrows, but in the meantime business presses, and so long as we have here hundreds of rolling mills in daily work, we can easily satisfy ourselves as to the capability of English engines to deal with violent fluctuations of load. Only last week we saw an English engine subjected to the most sudden and extensive fluctuation of load that electricians can devise without altering its speed so much as 1 per cent. But all these points are beside the mark, the real question is, does the fact of an American engineer advising an English company to adopt engines, of which he has had experience in his own dear native land, justify the belief that American engines are about to sweep the board and monopolise the English trade in electric traction? Not a bit of it, it simply illustrates the old adage that blood is thicker than water, and we are free to confess that if we were transplanted to the United States and charged with similar duties and obligations, we could scarcely hope to attain higher distinction than that of being a little "Parshall" ourselves.

Bicycles for Telegraph Messengers.—For some years past the Post Office has encouraged the use of bicycles by its telegraph messengers as an aid to the prompt delivery of messages. Hitherto the boys have in all cases used their own machines, the department making them a weekly allowance for wear and tear, maintenance, &c. The use of bicycles has been found so far satisfactory, that it has been decided to compare the cost of this allowance system with that of the supply of machines by the department itself. Consequently, 100 machines have been built to the Postmaster-General's order by the Quadrant Cycle Company, of Birmingham, and these will be issued in due course to selected towns in the kingdom for test. They are enamelled Post Office red, and the royal monogram is conspicuously displayed on the frame. It is intended to use a portion of these machines in the suburban parts of the metropolis; and it is not unlikely, therefore, that the modern (Post Office) Mercury, on his red-coated steel steed, will shortly be a prominent feature in our streets.

Prof. Waller on Animal Electricity.—In his third lecture, Prof. Waller showed the relationship between electrical indication and mechanical indication; the electrical indication was a faithful replica of the mechanical indication, and this feature was amply demonstrated by actual experiment. The difference between the muscle and the nerve in responding to stimulation was illustrated by curves; the muscular response grew by a "diminishing increase," while the relation between stimulation and sensation in the nerve was shown by a straight line. Equal increments of stimulation gave equal electrical effect. The muscle was an organ that multiplied the energy which it received, while the nerve was merely passive. Then a series of experiments were given showing the effects of alcohol, tobacco, and soda water. The soda water produced an excitable state, the effects of tobacco were most marked after a recovery from alcohol, and an overdose of alcohol abolished the excitability of the nerve, or, in other words, made it "dead drunk."

NEW COMPANIES REGISTERED.

Electrophone, Limited (50,849).—Registered January 13th with a capital of £22,000, in £1 shares, to acquire the business of a company of the same name, and to manufacture, construct, erect, maintain, lay down, carry out, buy, sell and deal in telephones, and all apparatus, appliances and things connected with telephonic communication or with electricity. The subscribers (with one share each) are:—H. O. J. Booth, 43, Gerrard Street, Soho, merchant; E. C. Engelbach, Windsor Mansions, Northumberland Street, gentleman; W. J. Glass, 31, High Street, Chatham, accountant; H. E. Cohen, Woodley, Cheshire, manufacturer; G. Ashton, 38, Old Bond Street, W., agent; W. Dore, 11, Little Chester Street, S.W., surveyor; P. W. Hearly, 89, Edith Road, W., gentleman. The number of directors is not to be less than three, nor more than eight; the first are to be appointed by the subscribers, subject to the approval of the director nominated by the National Telephone Company, Limited. Remuneration as fixed by the company. Registered by Hasties, 65, Lincoln's Inn Fields, W.C.

Wilson Manufacturing Syndicate, Limited (51,074).—Registered January 30th, with capital £2,000 in £1 shares, to adopt an agreement with R. P. Wilson for the acquisition of certain patent rights in connection with electrical apparatus and to carry on the business of electrical and mechanical engineers, machinists, brass founders, boilers makers, metal workers, &c. The number of directors is not to be less than three nor more than seven; the first are, C. A. Baker, V. G. Middleton, W. H. Story, W. E. Townsend and M. W. Stikeman; qualification £100. Registered by Windybank & Co., 35, Bucklersbury, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Venezuela Telephone and Electrical Appliances Company, Limited (31,305).—This company's annual return was filed on January 4th. The capital is £85,000 in 70,000 £1 and 1,500 £10 shares. All the £1 and 300 £10 shares have been taken up, and 56,506 shares of the former class are considered as paid. The full amount has been called on the others, and £16,494 has been paid.

Sussmann Electric Miners' Lamp Company, Limited (47,821).—This company's statutory return was filed on October 22nd. The capital is £80,000, in £1 shares (1,500 deferred, 39,250 preference, and 39,250 ordinary). 1,500 deferred, 27,073 preference, and 28,488 ordinary have been taken up, and the deferred, 17,950 preference, and 17,493 ordinary are considered as paid. £1 per share has been called on the rest, and £17,814 has been paid, leaving £1,854 to be brought in.

British Electrical and Industries Company, Limited (48,402).—This company's statutory return was filed on December 17th. Seven shares have been taken up out of a capital of £100 in £1 shares, but no calls have been made.

Standard Dynamo and Motor Manufacturing Company, Limited (48,471).—This company's statutory return was filed on November 10th. The capital is £2,000 in £5 shares (of which 60 are deferred); 200 ordinary and 60 deferred have been taken up, and 40 ordinary and the deferred are considered as paid; £5 per share has been called on the rest, and £795 has been paid, leaving £5 in arrears.

Pioneer Electric Carriage Company, Limited (39,009).—This company's annual return was filed on January 6th, when 64 shares were taken up out of a capital of £20,000 in £50 shares; £50 per share has been called, and £3,200 paid.

Pacific and European Telegraph Company, Limited (36,683).—This company's annual return was filed on December 30th, when the capital of £100,000 was fully subscribed for; £4 per share has been called, and £40,000 paid.

Preston Electric Company, Limited (48,495).—This company's statutory return was filed on November 12th, when 1,182 shares were taken up out of a capital of £3,000 in £1 shares; 925 are considered as paid, and £257 has been paid on the rest.

British Electric Traction Company, Limited (49,855). This company's statutory return was filed on January 18th, when 20,000 shares were taken up out of a capital of £600,000, in £10 shares; £5 per share has been called, and £93,176 10s. has been paid, leaving £6,823 10s. in arrears.

CITY NOTES.

London Electrical Cab Company, Limited.

The statutory general meeting of this company was held on Friday last at Winchester House, Old Broad Street, Mr. H. H. Mulliner presiding.

The Chairman said: Their attention had been called to several letters in the papers, wondering why a large number of cabs are not already on the streets of London. It was perhaps hardly necessary to explain that until the company was formed and the capital received it was quite impossible to order the cabs, and when they are ordered they required to be built, all of which takes some time. It would have been quite possible to have had one ready by now, and with this one they might have organised trial trips, &c., with news

paper reporters present, and have so created an impression that they were very busy people. But what would interest them much more would be to see a number of electrical cabs which would not only run as a trial trip, but which would run commercially, and which would be capable of earning a dividend to the shareholders. As far as actually running an electrical carriage is concerned, there is no difficulty about that. Mr. Bersey, whose services, and the whole of whose patents they had acquired the use of, has run electrical carriages several years ago which were quite as good, even then, as any electrical omnibus or other electrical motor carriages which have been seen or heard of recently. Since then and previous to the formation of the company, Mr. Bersey had wonderfully improved these carriages, and had already attained a great degree of perfection with them. Their responsibility was to build electrical carriages not only which would run along to the satisfaction of the users, and fulfil all the requirements of the Act, but which will be suitable to stand the immense amount of wear entailed by daily public use in London, and, what is still more important, they must be so constructed and so arranged, both as regards the supply of electricity and the durability of their parts, that they will be capable of earning good dividends for the shareholders. He had the very greatest belief in electricity as the future motive power for street traffic in London, where, in cases like the London Electrical Cab Company, it can be organised on a thoroughly businesslike basis—*i.e.*, they could have one experienced man responsible for the charging of the accumulators, and where you can contract with the supply companies and the accumulator makers, and they could have exactly the apparatus necessary for taking the accumulators on and off, &c. Then the drivers need have no knowledge at all of electricity, and have nothing to think of except conducting the vehicles, every precaution having been taken to ensure that these drivers should not be able in any way to interfere with and so possibly damage the electrical apparatus. He had 30 drawings, showing how thoroughly this work has been done; but the drawings, now they are completed, do not nearly represent the work which has been put into them. He believed these drawings now represent a perfect and suitable vehicle; they are the result of the whole of Mr. Bersey's experience of eight years, together with Mr. Brougham's experience as a practical electrician, and any experience he (the chairman) might possess as a practical coachbuilder. On the prospectus a report from Mr. Manville was published, and they naturally considered that no vehicle should be commenced until Mr. Manville had passed it as being, in his opinion, perfect. Before Mr. Manville passed these drawings and specifications, which he has now done, he thoroughly went into every point with us, and suggested many valuable improvements. Perhaps the most valuable improvement was the Johnson Lundell Series Parallel Controller. It is this invention which, during the last two years, had made electrical traction, as regards tramways, the huge success which it now is in America, and which is making rapid strides in England. Personally, he was no electrician, but had learned sufficient to be quite clear that this invention will produce the following results:—(1) It is the only invention which enables the electricity to be used in exactly the ratio that it is required, *i.e.*, there is no perpetual waste of electricity going on through resistance or other means, as is usual. This alone would save from 35 per cent. to 40 per cent. in the amount of electricity used. (2) It will considerably simplify the construction of the vehicle, by saving several complicated change of speed gearings, &c., and by saving these and the necessary handles, it will make the driving of the vehicle much easier. After considerable negotiations they had acquired the sole use of this invention for the purposes for which this company is formed, by payment of a royalty per vehicle, and after payment of this royalty, the price of the vehicle will be reduced below the cost at which it could be constructed without it. They had further gained the hearty co-operation of the British Thomson-Houston Company, the largest and most experienced makers of electrical traction apparatus in the world. After seeing these drawings, they could perhaps realise the further amount of work entailed by making specifications and obtaining estimates of each of the different parts with a new thing of this kind. This has now all been completed, and the work has been put in hand. Next as to the supply of electricity. Before deciding with any one company they had to be quite sure that they were getting the best terms it was possible to obtain. He considered that the London Electric Supply Corporation has treated them in a very fair spirit, realising the future business this industry may bring with. The contract with them had now been settled. Another step was to obtain suitable premises. In this direction they had been fortunate. They had taken a lease of large premises in the most convenient spot in London for trade, viz., Lambeth, near Westminster Bridge. Next the question of the electrical apparatus for transforming the electricity and for taking off and removing the accumulators, &c. This had to be worked out in the same way and tendered for, and is now on order. One more matter, and perhaps the most important—that is the accumulators. Mr. Manville drew up a complete statement of the various requirements, and invited tenders and samples from every maker of repute. These samples are being tested at Faraday House on a vibrating board, or as near as possible the same conditions they will be subjected to in actual use. Meantime, for their first vehicles they had to order accumulators, and they had been able to place this contract with the Electrical Power Storage Company, who were the oldest, largest, and far the most responsible makers of accumulators in the world, and, further, because they have after some years' experience perfected the Faure-King cell, and with this cell nearly all the former defects of accumulators disappear. After listening to the above, they would wonder when the vehicles will actually commence to run. They had done their utmost to hasten delivery, and, in fact, had made time the essence of the contracts, and had inserted penalty clauses in the agreements; but it will be three months, or nearly three months from now, before they were able to place any number of electrical cabs on the streets of London. Mr. Manville, who had gone to America on other business, is doing his best to hasten the delivery of certain parts ordered there. The more he had gone into this, the more confident he was that electricity is the future motive power for street traffic in London, and believed that the original shareholders in the London Electrical Cab Company will have much to congratulate themselves upon in the future. There was one thing more they had to congratulate themselves upon, viz., that instead of having to spend money in building works and putting down expensive machinery, &c., this company is, up to now, practically incurring no expenses whatever.

The Chairman, in reply to questions, said that the total amount subscribed by the public was something like £63,000, and the vendors were most reasonable with the company in making the following conditions: First, that the proportion of working capital should remain exactly the same as stated in the prospectus, viz., the unusually large amount of two-thirds working capital, and one-third to the vendors. This left about £42,000 working capital, which is ample to prove the success of this business, and when that success is obtained then the balance of the company's capital will be readily subscribed at a good premium, of which the shareholders will have the benefit. Then, and not until then, would the vendors receive the balance of the agreed purchase price. The £63,000 has been fully paid. The first lot of cabs which would be put on the streets would be 24 in number, but that is no exact criterion, because as soon as these are built the others will come on quickly. The actual commencement will be with 24 cabs, the others coming on as fast as there is a demand and they can be finished off.

The proceedings then terminated.

Waterloo and City Railway Company, Limited.

The general meeting of this company was held at Waterloo Station yesterday.

The Chairman (Mr. Wyndham S. Portal) said the works have continued to make satisfactory progress since their last meeting. The authorities with whom they came in contact have been very considerate in their dealings with them. After referring to the loss to the company occasioned by the death of Mr. J. H. Greathead, they had selected in his place Dr. A. B. W. Kennedy, and they had confidence that the work would go on well. Dr. Kennedy had stated that specifications had been sent out to a number of firms which covered the whole of the electrical equipment of the line, and tenders had been received from several firms, and these were under the consideration of the board. The contractors are giving entire satisfaction, and the directors were contented with the position of matters. The Parliamentary period for the completion of the line expired in March 1898, but they hoped to be ready before that time. They were watching the various other railway schemes in order to protect the interests of their own undertaking. They had expended £67,337 during the half-year, making the total outlay £280,526. The retiring directors were re-elected, and at a subsequent general meeting a Parliamentary Bill for further powers in respect to joint undertakings with the London and South Western Railway and the London, Brighton and South Coast Railway Companies was approved.

Central London Railway Company, Limited.

At the meeting of this Company held yesterday, Mr. Henry Tennant presided. In moving the adoption of the half-yearly report to December, 1896, and the payment of 3 per cent. per annum interest on the paid up capital, he referred to the progress that had been made with the line since the last meeting. The sinking of shafts had to a large extent been accomplished, and from these shafts tunnelling was in progress at ten different places upon the line, and in the two tunnels there are now 15 shafts at work. Sir Richard Farrant, the chairman of the Electric Traction Company, was congratulated upon the knighthood conferred upon him, and the relatives of the late Mr. J. H. Greathead, the engineer to the company, were condoled with. The expenditure during the half-year amounted to £365,228 odd, making a total of £807,326. The negotiations with the G.E. Ry. and N.L. Ry. for a site at Liverpool Street had not been successful. The resolution was seconded by Lord Colville of Culross, and carried.

The Chairman explained that negotiations for the Davies Street site had terminated for the present, and a special meeting was held after the general meeting to approve of the application to Parliament for a Bill to acquire property on the north side of Oxford Street, very nearly opposite the Davies Street site, which would simply mean moving the station about 66 yards eastward. The Chairman moved, and Sir Francis Knollys seconded the approval, and this was carried with two dissentients.

Willans & Robinson, Limited.

The extraordinary general meeting of this company, which was held on Tuesday at Cannon Street Hotel, was free from the least discordant note, though the directors were asking for powers to raise additional capital. The remarks of the chairman (Mr. Mark Robinson) told from first to last of increasing prosperity. He gave a good tone to the proceedings by endeavouring—but with very little

effect—to get shareholders to ask questions or offer opinions regarding the various details connected with raising the new capital. He, however, anticipated in his own speech the many questions which shareholders are wont to ask at such meetings by explaining in a very lucid manner why the new capital was necessary, how it would be spent, what amount was wanted immediately, why the directors had not waited until the annual meeting to bring the matter forward, &c. Therefore there was little left for shareholders to say but of a congratulatory nature. One suggestion was made by a shareholder, and was endorsed by a director, which the board would do well to consider between now and the annual meeting, *i.e.*, the addition to the board of one or two more business men to assist in the management. The chief feature in the chairman's remarks was the fact that the enormous increase in the demand for Willans engines is due to the extension of electric lighting plants which already existed, which demand he thought they had every reason to suppose would continue. Mr. Robinson gave the following figures:—

In 1893 the orders reached close upon	19,000 I.H.P.
In 1895 the orders totalled nearly	28,000 I.H.P.
An increase of over 50 per cent.	
In 1896 the orders reached the astonishing figure of	43,500 I.H.P.

No one, he said, would doubt the cogency of these figures or their generally happy augury for the company. He believed they had only touched the borders of a field of work which would keep the company and its rivals busy for a long time to come. The year 1897 opened with orders unexecuted for engines of a horse-power amounting to nearly the whole year's possible output as the company was at present situated. Many of the orders were partly or nearly completed now, but allowing for that, they had an enormous quantity of work in hand which had to be finished before they could look at new orders, and that was not altogether a wholesome state of affairs. Unless they promptly increased the capacity, their position might become a serious one. They had to thank municipalities and other large customers for very considerate treatment, but they could not always reckon upon that. After going into the capital account of the company, he stated that the balance left in the hands of the directors, £34,000, had been absorbed as working capital, and £8,000 more as well. The estimated output for 1897 was from 35,000 to 40,000 I.H.P., but they wanted to increase that producing capacity to 60,000 I.H.P. They proposed to add 50 per cent. to the capacity of the machinery and erecting shops at Rugby.

The resolution, which was carried, was to the effect that the directors be authorised to issue, upon such terms and conditions as they might determine, the unissued capital of the company, 7,500 preference and 7,500 ordinary shares." The shares will be issued *pro rata* at a premium.

The St. James's and Pall Mall Electric Light Company, Limited.

The ordinary general meeting of the shareholders of this company was held on Tuesday last at the offices, Carnaby Street central station, Golden Square, under the presidency of Mr. Eustace J. A. Balfour, the chairman, who said:—I have, I am glad to say, only a few remarks to make, and first of all I will ask you to excuse me personally, because I have got a very bad cold, and perhaps ought not to be out at all. The first point to which I wish to call your attention, is the fact that we propose a dividend of 10½ per cent. as against 7½ last year, and 6½ the year before on the ordinary shares. The preference shares, of course, take their 7 per cent. dividend, and on the founders' shares we propose £36 17s. 6d., which is at the rate of 3,600 odd per cent. During the past year there has been an increase of lamps of 17,017, as against an increase of 16,569 last year, making a total of 108,803 8-candle-power lamps. I hope you will observe that not only has there been an increase, but an increase in the rate of increase, which is even a more important element in the question. The output at stations was increased by about half a million units, as against an increase of about a quarter of a million of units for the preceding year, so that it is not only that we have an increased number of lamps, but the lamps which we have gained are earning a larger income than the average of our previous lamps. The total cost of production per unit, apart from special charges under the head of depreciation, has been further reduced by 15 per cent. We have completed our operations in Mason's Yard, and the new plant there has fully answered all the expectations of the directors, and now we have no further complaint of any nuisances to which the old plant was liable. We shall, of course, be shortly obliged to carry out further extensions at the stations, and the directors will probably have to consider, during the coming year, even wider extensions than that; but of that we know very little at present, and we shall carefully and slowly consider what is absolutely necessary. As will be seen from the report, there has been an expenditure, allowing for depreciation, of about £9,000; a portion of this is for new mains, strengthening and extending the company's system, and the remainder for public lighting. These latter lamps will shortly be in operation. There are about 12 public lamps erected, and they are being got on with day by day. Now, gentlemen, I have very little more to say. I shall be very glad to answer any questions which any shareholders may put to me; but I think that we may fairly congratulate ourselves upon the work of the past year. I think that all our labours of previous years are really now beginning to bear fruit, and that we may congratulate ourselves that we have before us a fairly smooth career, and I hope, for all of our sakes, a career of reasonable annual profits. In conclusion, I beg to propose "That the report and accounts for the year ending December 31st, 1896, as submitted by the directors, be read and accepted, and that the dividends recommended therein be declared and paid on February 12th, 1897."

Mr. Latimer Clark, F.R.S., seconded the motion.

Mr. Neville asked how the dividend was appropriated to the founders' shares. He said that the total amount appropriated to the holders of those shares was very nearly a half of the total amount appropriated to the 19,980 holders of ordinary shares. As the chairman had observed, the dividend and the founders' shares worked out at about 3,600 per cent.

Mr. Foster said he would like to know how it was that the total expenditure, less depreciation, to December 31st, 1895, appeared in one account at £237,000, and in this year's account at £233,000.

Mr. Pember explained that it was due to the management and other expenses being charged to revenue, instead of to capital, at the wish of the Board of Trade. It was not mentioned at the last meeting, but it was referred to in this year's report for the first time.

Mr. Foster said that in the balance-sheet there appeared an item "net loss on sales of old plant." He would like to know what that old plant cost.

The Chairman said that at the meeting last year he told them that during the period then under review, rather more than one-half of the old plant had been sold at a loss of £2,000, which had been charged to the revenue of that year, and satisfied with the success of the new engines, the directors had decided to sell the remainder of the old engines and plant, and completely re-equip the station; and a further loss of about £1,500 must be expected as a charge on the current year's working.

Mr. Foster: Would that be about a half loss or three-quarters?

The Chairman said he could not exactly say at the moment, but practically they might say it was a loss of 50 per cent.

Colonel Francis said he wished to call attention to the amount of fees taken by the directors—not in any spirit of animosity, but because he would like them to look carefully into the matter as he had done. By the articles of association the directors were entitled to a fee limited to £1,500, but they had taken a sum considerably in excess of that—no doubt thinking they were only exercising their rights. In fact, the directors had received very nearly as much as the whole of the skilled and scientific staff of the company, and they took as much as the whole of the coal supply cost. These were very important figures, for they might look forward with great hope to an increase in the receipts of the company, and in the profits to be divided, and there was apparently no limit to the sums of money which the directors might receive. He knew he would be told that when the articles of association were revised the directors' fees were altered; but he had taken counsel's opinion on the point, and had been told that the directors had no right to do what they were doing. Practically, the directors were the masters of the shareholders, instead of their servants.

Mr. Francis Bourn asked whether all hope had been abandoned of obtaining the founders' shares, and whether they must be purchased *en bloc*? If they could be purchased singly, perhaps the board might be able to appoint some person to negotiate with the individual holders, and buy them from time to time on behalf of the company. By that means they might gradually become possessed of these shares, which undoubtedly became more valuable each year as the prospects of the company improved. He would not wish to obtain the shares at other than a fair price, but it would unquestionably be to the advantage of the company if they could be bought up.

The Chairman, replying to the questions, said that according to the articles of association, after 7 per cent. was paid on the ordinary shares, half of the net profits went to the founders' shares, and they could not alter that. Col. Francis had complained of the amount taken by the directors in fees, but that was strictly according to the articles of association. The question had been discussed more than once, and it was always open to shareholders, if they thought fit, to refuse the money if they thought they were taking too much. They had no wish to take excessive amounts; they only wished for a reasonable remuneration for the work they did for the company. Respecting the founders' shares, the directors were very anxious indeed to buy them up, and they had never relaxed their efforts in that direction, but it depended entirely upon the holders, as they need not part with their shares unless they liked. Unfortunately, they were advised that the founders must be unanimous before any action could be taken. No shareholder could be more anxious than were the directors to see the founders' shares bought up, but the question was a very difficult one. To some extent, of course, it was a question of price. The board would have to obtain the sanction of the shareholders to any proposal they might make, and, of course, they would not sanction any unreasonable proposals.

Mr. Bourn: Any founder can sell his shares, and I thought the board might possibly be able to get hold of them individually.

The Chairman: Of course, the company as a company cannot buy shares.

Mr. Bourn: No; but they might perhaps be able to depute some person to buy on their behalf.

The Chairman said that if Mr. Bourn or any other shareholder could assist the company by buying founders' shares, they would be very pleased.

The report was then adopted unanimously.

Sir J. Morris said he had much pleasure in proposing the re-election of the two retiring directors, Mr. Eustace Balfour and Mr. Latimer Clark. Both these gentlemen had, he said, been directors of the company since its formation, and Mr. Balfour had been chairman for the last seven years. Mr. Clark was not only a practical and scientific electrician, but with the care and attention he had devoted to the company, he had done more to promote its interests than perhaps any other director.

Mr. Bourn seconded, and the resolution was carried *nem con.*

The Chairman, in thanking the meeting for his re-election, said he could assure the shareholders that he and his colleagues had the genuine interests of the company honestly at heart, and that they felt infinitely more proud at the success that had attended the company, than at anything else in connection with it.

Mr. Latimer Clark also thanked the meeting for his re-election.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., having been re-appointed,

The Chairman remarked that a great deal of the success which had attended the company was due to the extremely efficient permanent staff they had. He specially wished to thank their general manager and secretary, Mr. Walker; and the chief engineer, Mr. Dobson; and all the rest of the staff for the conscientious and brilliant way in which the business of the company had been carried on.

Mr. Bourn then proposed a vote of thanks to the chairman and directors, and the staff.

Mr. Sams seconded the motion, which was carried, and the proceedings terminated.

The Yorkshire House-to-House Electricity Company, Limited.

The ordinary general meeting of the Yorkshire House-to-House Electricity Company, Limited, was held on Tuesday afternoon at the Great Northern Hotel, Leeds, Mr. Grosvenor Talbot being in the chair.

The Chairman, in the course of his remarks, congratulated the shareholders on the handsome profit which had been made during the past year's trading, the revenue showing, in comparison with that of 1895, an increase of 29 per cent., while the expenditure had only increased by 9 per cent. The units of electricity sold in 1896 were 701,409, as compared with 524,629 for the previous year, giving an increase of 176,780. Had it not been for the protracted strike, many more lamps would have been installed. As it was, customers were told that it was impossible to meet their requirements. The company had made an offer to the Leeds Corporation to light the streets of the city with electricity, or any part of them that the Corporation desired. As an experiment, the directors were prepared to supply lamps from the Central Station to the end of Boar Lane, and from the Leeds Bridge in Lower Briggate to the Dispensary in Upper Briggate, at an annual cost of £500, which was considerably less than any company floated specially for that purpose could afford to do it at. Indeed, the directors believed that it would be less than the present cost of gas; and it was hoped, in the interests of the citizens, that a step such as he had described would be undertaken. With regard to the proposed raising of additional capital, the directors were at present spending a large sum in extensions, and it was felt desirable to augment the capital, which at present stood at £105,377 3s. 1d., by issuing 20,000 ordinary shares at £5, making the total capital £200,000. To every shareholder the directors offered one additional share for each share he held. The directors felt it was only just to the shareholders, they having accepted the possibility of risk when the company was formed, to bestow upon them every benefit in their power; and consequently it was gratifying to the directors to be able not only to pay a very reasonable dividend, but to give to the shareholders a handsome bonus. The issuing of the new shares at par really amounted to that, for shares were at present being quoted at 8¼ and 8½. It would only be necessary at present to call up half of the sum required, and the remainder would be asked for when required. Possibly the shareholders might think that this was a considerable demand upon them; but they must remember that electric light companies were different to ordinary trading companies. They had a larger field—their company had the whole of Leeds; and it was certain that from time to time it would be necessary to augment their capital. Speaking generally, there was now no difficulty in raising money for the purposes of electric supply. There were at present 120 supply stations in England with a capital of £9,000,000; and 25 new companies were authorised or in course of formation. Therefore it might be taken for granted that the public still had confidence in that class of investment. In conclusion, he moved the adoption of the report, which was agreed to; and a dividend at the rate of 7 per cent. was declared.

The Chairman then formally moved that the capital of the company be increased to £200,000. Mr. A. G. Lupton seconded, and the resolution was carried unanimously.

The retiring directors (Messrs. S. Ingham and G. H. Crowther) were reappointed, as was also the auditor (Mr. J. Gordon, jun.), and the meeting concluded with the usual vote of thanks.

Cambridge Electric Supply Company.

The fifth annual general meeting of this company was held at the company's offices, Thompson's Lane, at noon last Friday.

The Chairman (Mr. D. Munsey), in moving the adoption of the report, said that at the end of 1893, they had a revenue account of £272, and no dividend was declared. In 1894 they had £933 and a dividend of 2½ per cent. was declared. In 1895 their revenue account was £1,490, and a dividend of 3½ per cent. was declared. In 1896 they had £2,490, and were able to declare a dividend of 5 per cent., this showed that the company had prospered, and the increase in the number of lamps also pointed to the same conclusion. The directors considered it exceedingly satisfactory that the 47,105 extra units had been produced on less coal than was used in 1895. All their machinery and the buildings and plant altogether were in a very satisfactory state. They had, also, he was glad to say, been able to complete the arrangement of their staff in a more satisfactory manner than hitherto. They had acquired the lease of eight houses opposite the works so that their workmen might be on the spot. The directors were taking great pains to see that the men were properly housed, and he believed the workmen were exceedingly grateful for this attention. In 1895, the company spent a considerable sum on substations and in laying down extra machinery, &c. All these improvements had resulted in the most satisfactory way. They had paid remarkably well. He had no doubt that, in the present year, they would be able to hold their own and go on increasing as in the past.

Sir B. C. Browne seconded the adoption of the report, which was adopted,

The Chairman then proposed the payment of a dividend of 5 per cent.

Mr. Stubton, seconding the motion, said he had no doubt that the 5 per cent. would increase to 10. When the electric light was more used, doctors would, no doubt, be able to announce a considerable diminution in the number of bronchial and pulmonary complaints.

Mr. Simpson: Doctors won't like that.

The motion was agreed to.

Sir B. C. Browne and Dr. Latham were re-elected directors, and Mr. A. Rutter, auditor.

The meeting then ended.

Westralian Electric Lighting and Supply Company, Limited.

The prospectus of this company is before us. The list opened on February 1st, and closes to-morrow, February 6th, for an issue at par of 30,000 7 per cent. cumulative preference shares of £1 each, the total share capital being £110,000. 70,000 ordinary shares (£1) have been privately issued and allotted, and 10,000 are held in reserve. The company was registered in September, 1895, to acquire and work an exclusive concession for the supply of electric light and power to the municipality of Coolgardie for a period of 21 years, and also with a view of securing and working similar concessions for other towns in Western Australia, and to supply light and power to the mines in that colony. The central station buildings have been erected and the plant at present consists of four oil and two steam engines, dynamos, and accumulators, but owing to the number of applications for light a further complete installation has been purchased, part of which is already on the way out to the colony, and the consulting engineer reports that when installed it will be capable of supplying 3,500 16-C.P. lamps. The number of lamps connected and applications for private lighting is equal to 1,950 16-C.P. lamps. Mr. G. L. Addenbrooke, who is the consulting engineer, has submitted a report which is published in full with the prospectus.

The directors are Bennett Finch, M.I.C.E., Alfred Bull, E. Harris, and Sydney C. Hunt. Mr. G. H. Homan is the secretary, and the registered offices are 54, Old Broad Street.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee:—(1) To appoint a special settling day in, and to grant a quotation to:—Commercial Cable Company, £400,000 sterling, 4 per cent. 500-year debenture stock; and (2) To appoint a special settling day in: London Electrical Cab Company, Limited, 62,768 shares, Nos. 1 to 62,768.

National Telephone Company.—The transfer books in respect of the preference and ordinary shares will be closed from 5th to 18th inst., both days inclusive, preparatory to the payment of the dividend for the half-year ending December 31st. The dividend warrants will be posted on 18th inst.

Great Northern Telegraph Company.—This Company has advertised a list of numbers of 100 series "B Debentures" of £100 each of 1883 which have been drawn for payment on March 1st, and which are to be paid by Messrs. C. J. Hambro & Son, 70, Old Broad Street, E.C.

The Westminster Electric Supply Corporation, Limited.—The board give notice that, subject to audit, they will recommend the payment of a dividend for the past half-year at the rate of 12 per cent. per annum, making with the interim dividend already paid, 9 per cent. for the year 1896.

Newcastle and District Electric Lighting Company.—The directors recommend a dividend for 1896 at 7 per cent. per annum.

Cuba Submarine Telegraph Company.—The directors announce a dividend of 8 per cent. per annum for the half-year.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 31st, 1897, were £1,101; week ending Febuary 2nd, 1896, £991; increase, £110; total receipts for half-year, 1897, £5,499; corresponding period, 1896, £5,036; increase, £463.

The Liverpool Overhead Railway Company. The receipts for the week ending January 31st, 1897, amounted to £1,227; corresponding week last year, £1,044; increase, £183.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 29th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,553.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Jan. 27th.	Closing Quotation, Feb. 3rd.	Business done during week ended Feb. 3rd, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,612,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	...	53 — 56	53 — 56	54	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	...	97½— 98½	98 — 99	99	98½
2,993,560£	Do. do. Defd.	Stock	...	...	...	9½ — 10	9½ — 10	...	...
138,080	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15½ — 15⅝	15½	15⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	170 —175	170 —175	171	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	12 — 13	12 — 13	...	...
5,000	Do. 10 % Pref.	10	10 %	10 %	...	18½— 19½	19 — 20	19½	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	105 —108 %	105 - 108%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	...	9½— 10	9½— 10	9⅝	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17½— 17⅝	17½— 17⅝	17⅝	17⅜
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅞	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	104 —107	103 —105 xd	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	129 —132	130 —133	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17½ — 18	17½— 18	17 15/16	17⅝
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 - 104	100 —104	102	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	130 —133	129 —132 xd	130	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 - 104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
800,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	108 —111	107 —110 xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	109 —112 %	110 —113	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	10⅜— 11⅛	10⅜— 11⅛	11⅛	10⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17½ — 17⅝	17½ — 17⅝	17 11/16	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	...	24½ — 25½	24½ — 25½	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	106½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 56	53 — 56	55⅝	55½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Prev., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	...	7⅜— 8	7⅜— 8	7 15/16	7⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	17 — 19	17 — 19	18½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	6⅜— 7	6⅜— 7	6 13/16	6⅜
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	105 —108	105 —108	107½	105¾
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4¼%	5 %	...	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	106 - 109	106 —109	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	...	7 — 8	7 — 8	...	...
3,281	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	141	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 3⅝	3½— 3⅝	...	...
145,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	102	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	...	5 — 6	5 — 6	...	...
238,380£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 —106	104	...
29,060	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	0 — 1	½ — 1	¾	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	93 — 99	96 — 102	100	...
54,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	8⅜ - 9½	9 — 9½	9⅜	9½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6¾ - 7½	7 — 7½	7½	7 3/16
33,129	Do. do. do. Def. Ord.... ...	7½	1 %	1 %	...	2⅜— 3½	2⅜ — 3½	3	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	110 —114	110 —114 xd	110½	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113 xd	113	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	...	1⅛— 1⅜	1⅛— 1⅜	1⅛	...
24,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11½— 12	11½— 12	11 9/16	...
4,562	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½— 10½	9½— 10½	10¼	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	107 —112	107 —112	...	...
164,380£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

80,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	...	9⅜— 10½	9⅜— 10½	10	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	8½— 9	8½— 9	8⅞	8⅝
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	...	112 —115	112 —115 xd	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	...	15½— 16½	15½ - 16½	16½	15 11/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	16½ — 17½	16½— 17½	17½	17 3/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	128 —132	128 —132	130⅝	130½
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	...	½ — ½	9½— 9⅝	9½	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	...	13½— 14	13⅝— 14½	14	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	9½ — 10½	10 — 10½	10¼	10
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	...	13 — 14	13½— 14½	14⅜	13 11/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6⅝— 7½	6⅝— 7½	7⅛	6⅝
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	119 —122	119 —122	...	...
5,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	...	11 — 12	11 — 12	11⅜	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	13 — 14	13 — 14	13⅝	13 7/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ - 10½	9½— 10½	9⅝	9½
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	...	11½— 12½	11½— 12½	12 5/16	12

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896	Closing Quotation, Jan. 27th.	Closing Quotation Feb. 3rd.	Business done during week ended Feb. 3rd, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	£	2½%	...	...	⅞ — 1⅛	⅞ — 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	...	...	1⅛ — 1¼	1⅛ — 1¼	1⅛	...
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	109 —112	109 —112	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 — 98	94 — 98	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10	...
207,649	Do. do. do. £6 paid	10	...	...	...	3¾ — 4	5⅜ — 6¼	5 13/16	3 13/16
630,000	City and South London Railway	Stock	1⅛%	1 2/16%	1 9/16%	59 — 61	58 — 60	60	59⅛
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	£	*nil*	*nil*	...	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	£ 5	5 %	5 %	...	1⅜ — 2¼	1⅜ — 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	£ 5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	£	*nil*	5 %	...	1½ — 1⅝	1½ — 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	£	7 %	7 %	...	2½ — 3	2½ — 3	2 13/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	£	*nil*	...	...	⅝ — ⅝	1 — 1¼	1¼	⅞
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	£	*nil*	...	...	⅛ — ⅛	⅝ — ⅝	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	£	*nil*	10¼%	...	10½ — 11½	10½ — 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	£	6 %	8 %	...	18 — 19	18½ — 19½	18 9/16	...
3,000	Do. do. do. 7% Pref.	£	7 %	7 %	...	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	...	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	£	10 %	10 %	...	20½ — 21½	20½ — 21½	21½	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	£	...	...	...	106 —109	106 —109	...	...
37,500	†Liverpool Overhead Railway, Ord.	£	1½%	2⅞%	...	13½ — 13¾	13½ — 13¾	...	...
10,000	† Do. do. Pref., £10 paid	£	5 %	5 %	...	16½ — 17	16½ — 17	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	£	20 %	15 %	...	40 — 43	40 — 43	42	41
150,000	Do. do. do. 5 % Bonds, red. 1899	£	5 %	5 %	...	102 —105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	£	...	...	...	7½ — 8	9¾ — 10¼	10⅛	8

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 80% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9.
Electric Construction Corporation, 6 % Debentures, 101—104.
House-to-House Company (£5 paid), 4¾—5¼.
Do. do. 7 % Preference, of £5, 8¾—9¼.
Do. do. 4½% Debentures of £100 107—109 xd.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10¼—10¾; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½.
London Electric Supply Corporation, £5 Ordinary, 1⅜—1⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—9

* From Birmingham Share List.

Bank rate of discount, 3½ per cent. (January 21st 1897).

ELECTRIC STREET RAILWAY RETURNS.

Some interesting notes on the electric railway return, by G. W. Knox, electrical engineer Chicago City Railway, are published in the *Street Railway Review*. Mr. Knox gives a humorous description of how rail bonds were made in the good old primitive days of electric railway work. The engineer in charge dropped into the nearest hardware store, picked up some boiler or stove rivets and a bundle of No. 6 or No. 8 iron wire, which was in stock for farmers' fencing, handed the material over to a labourer with instructions to cut the material into 2-foot lengths, twist it around under the head of the rivet, and then, after dipping the ends of these so-called bonds in solder, to go out and bond the joints of the rails. Pat was left to drill holes in the rails and fix on the bonds as he thought fit. The rivets often proved much too small to fill the holes, but the faithful son of Erin was ever equal to the emergency; a convenient longer rivet was usually found which could be dubbed back, and with a little more hammering be made to fit the hole.

Experience has shown, according to Mr. Knox, that the earth as a conductor for currents of the volume employed in street railways is absolutely valueless. There is but one thing left to do, and that is to have an absolute metallic return conductor. Three plans may be adopted for securing the desired metallic return:—A complete copper return; a metallic return made by heavily bonding the rails and using a supplementary wire in connection therewith; or, joining the rails so as to secure the full value of their current carrying capacity.

Mr. Knox admits that the complete copper return is the only perfect system, but considers that it means a tremendously large outlay of money for copper, which appears to be especially unwarrantable when there is any amount of return conductor in the shape of rails, provided good connections can be made at the joints.

Mr. Knox appears here to have in his mind the use of an uninsulated conductor running parallel to the rails, and connected to it at intervals by branch conductors. This plan, of course, involves the use of a very heavy and expensive copper conductor, since the whole return current is propelled by the comparatively small voltage permissible between the terminals of the railway and the central station. Taking a hydraulic analogy, we can see that when the fall is not great, a large conduit is required to carry a current of water which can be easily forced through a small pipe by the help of a powerful pump. The application of this principle to electric railways does not yet appear to be fully understood by American electrical engineers, notwithstanding their vast experience in the construction of the electrical street railways. The golden rule is to save money on your return conductors by making them small, and spend a little extra on the dynamo to enable it to pump the whole return current through the small return.

Whether Mr. Knox is aware of the existence of the booster return or not, he falls back on the bonded rail return as the only practicable plan. Experience, however, has shown him that the very best bonds are defective. The contact of the best bonds with the rails is never complete, and corrosion, assisted by the passage of the current, readily takes place in the interspaces. Some of these bond terminals, after about two years use, were found coated with oxides of iron and copper, and showed only about one-third of the surface bright where there had been good contact.

Mr. Knox recommends the following plan for obviating to a great extent the corrosion difficulty:—"First dip the terminal of bond in solder. Have the solder very hot, so there will not be a heavy coating of it on the terminal, thereby making an unnecessary increase in resistance. Next apply, in a thorough manner, a coating of metallic composition, known as plastic alloy, to the walls of the hole in the rail; apply the bond in the best possible manner, follow up by coating with a preparation consisting of two-thirds tar and one-third pitch all around the bond terminal on each side of the rail web, and pack sand ballast tightly about the joint

thus made. This plastic alloy is comparatively new to the trade. I have made some tests with it, applying it to iron, and afterwards immersing the iron thus treated in salt water, and the parts coated with the alloy do not show a particle of rust. Just how it compares with copper as a conductor I am unable to say, but believe, from tests made, that it is a fair conductor. There is a possibility of the tin and plastic alloy thus interposed between the copper of the bond and the iron of the rail acting, to a degree, as resistance, but this never can equal the extent of the difficulties which we now encounter by the corroding of the bond terminal, as well as the walls of hole in rail."

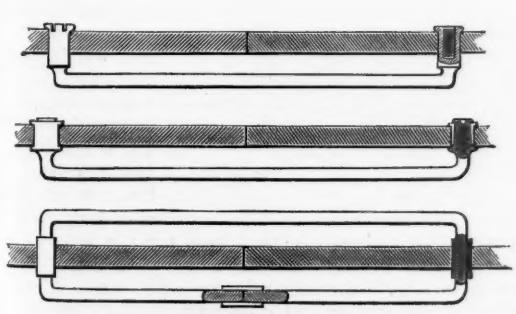
But he thinks that in future the best results will be attained with the cast welded joint. The drawback at present in applying this joint consists in the difficulty of thoroughly cleaning the rail joint from rust. The promoters of the cast joint idea are getting out a machine for this purpose. When this is done, Mr. Knox considers that a perfect amalgamation between the joint and the rail may be obtained. In the cast welded joints which he has tested, he has found no appreciable drop across their parts; but he admits that the results may not be the same with the large currents used in practice as with the comparatively small currents used in the tests.

Mr. Knox insists on the importance of tying together in a thorough manner the tracks at all intersections, so that the return may have as many paths as possible back to the power station.

Mr. Knox gives the following description of the three bonds which are most in use by the leading large roads in America:—"Fig. 7 illustrates the 'Chicago' rail bond, which is the pioneer in the way of a large and substantial bond. To the inventor of this bond is due the credit of being the first one to realise the necessity of having a large capacity bond with a terminal having a surface contact with the rail seven or more times that of the sectional area of the bond wire, thus making up for the difference in the conductive ratio of copper and iron.

"It is a strictly one-piece bond, made up by having an enlarged terminal drawn on each end of wire with a hole in the terminal allowing for a drift pin about $\frac{1}{16}$th larger. The enlarged ends or terminals of wire are inserted in the holes of the rail, and the ends expanded with a drift punch to hold it in position while the drift pins are driven home, expanding the terminals of bond until thorough contact is made with the walls of the hole in rail. The drift pin should be driven into the terminal until the front end of drift pin is about $\frac{1}{8}$th inch through the web of rail. This process expands the terminal on both sides of the rail, making it impossible to have the bond work either way out of the rail. The bond is very easily and quickly applied.

"Fig. 8 shows a diagram of the Columbia bond. This bond is a comparatively new arrival in the field. As the diagram shows, a truncated cone head terminal, with a fillet



Figs. 7, 8, and 9.

at the base, is formed on each end of the wire. These terminals fit into a thimble which is made exactly to the taper of the terminals. The outside of these thimbles is tapered slightly in an opposite manner to allow them to go into the holes in rail readily.

"The manner of applying the bond is this: First the thimble is inserted in the holes of rail from one side, and the conical shaped terminal inserted in the thimble from the other side, then forced into and expanding the thimble until perfect contact is made with the walls of the hole in the rail. The end of terminal is then expanded with a centre punch while the pressure is still on the terminal, locking it firmly in position. The construction of this bond is such that it allows for the terminal being forced into the holes in rail until a perfectly tight fit is secured; should the hole be a trifle too large or too small it will adjust itself, and this is not accomplished by the mauling of metal process, before spoken of, as it is a compression strain on metal at the time of fastening of the terminal. With the greater number of bonds offered, the manner of applying them tends to weaken them, for mechanical strains, just where they should be strong, that is, at the terminal just outside of the web of rail, for in forcing the metal out in contact with the walls of hole in rail it is liable to nick and weaken the terminal. With this bond, nicking will take place only on the thimble, which does not necessarily have to stand any of the strain brought upon the bond wire through expansion and contraction of rails. This bond may be taken out and used over again.

"Fig. 9 illustrates the Brown bond designed for the West End Road of Boston. It consists of a wire having a soft steel thimble sweated on where it passes through the web of rail. The thimbles are slightly tapered and driven into the web of rail with a sledge and follower. This style of bond is often used in double form, that is, the ends pass through the web, are brought together, and connected with a sleeve. The thimble is about $1\frac{1}{2}$ inches long, thus, it is claimed, making the required extra amount of surface contact between the copper of bond wire and the metal of rail. The use of steel to steel, as mechanically employed with this bond is very commendable, as it is possible to force the terminal in place in a very firm manner, and there is but little danger of injuring the softer metal, the copper wire."

TELEGRAPH AND TELEPHONE POLES.*

By ALB. PETERSEN.
(Telegraph Engineer, Norwegian Government Telegraphs.)

"What kind of wood shall be used, and how shall the wood be treated, to enable telegraph poles to last the longest possible time?" This is a question which has been under consideration ever since the commencement of telegraphy.

In the North and Central Europe, the fir and the pine have been almost exclusively used. The winter is selected for cutting the tree, because at that season the amount of sap is less than at any other time. Without entering upon the later treatment of the wood, I shall here only mention the impregnation of the timber with sulphate of copper or with creosote oil. These two treatments, if carefully carried out, have proved useful in guarding the timber against decay.

Efforts, however, are still being made to perfect the treatment of telegraph poles, not alone on account of the economical side of the question, but also because it is a necessary requirement for the solidity or life of a telegraph line.

The following observations may therefore be of some interest:—

By travelling along a projected Government telephone line in "Sætersdalen," in Norway, I came across some of the peculiar ancient store houses on pillars ("Stabur"). These constructions are built from log wood, and on the whole of very large timber. They are sometimes several centuries old, but in spite of this the peasants prefer these old logs for ordinary building purposes to new timber, because, as they say, there is no wood like the old wood.

I could not help thinking—"Is it really possible that this kind of wood was better in olden days; or did the old peasants only use heart wood? Or is it because the trees then were so large that all the sap wood could be removed, that the old timber was so good that it still, after the lapse of centuries, appears perfectly fresh." At last, in passing

* *Telegrafbladet*, Kristiania.

through "Valle," about 160 kilometres further on in the valley, I obtained from the peasants some information, handed down from generation to generation, as to the treatment of this timber, according to which it appears that the pine, selected for house timber, was stripped during the summer of its bark for a distance of about 12 feet from the ground. The tree was then left standing till the following summer and then cut down. By treating the timber in this manner it became exceedingly resinous.

(This phenomenon we find by examining the dry knot-branches on growing firs. These dry branches are at times so full of rosin, that the whole of the branch consists of nothing else but knot-wood.)

The struggle for life by trees, treated as above, will still cause the tree to try to obtain nourishment; but as it has no power to assimilate it, the amount of rosin continually increases.

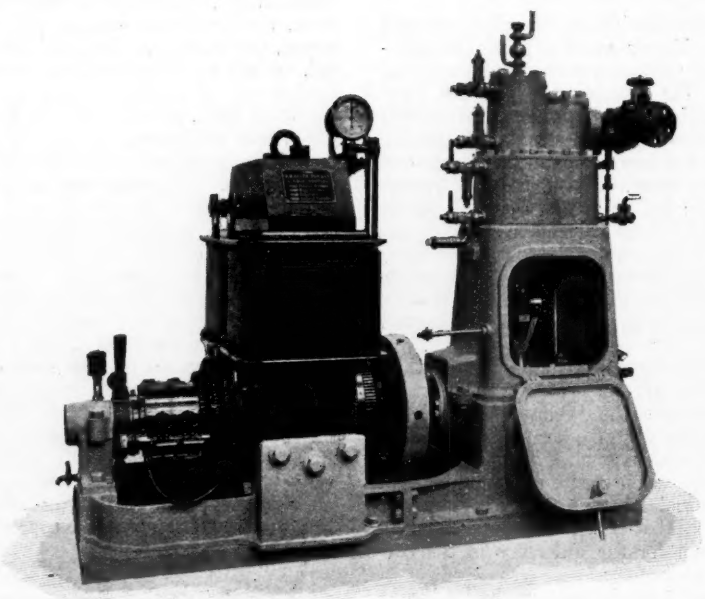
It is not impossible that in the above we may ultimately find a new treatment for our telegraph poles. The greater the amount of rosin in the telegraph pole, the less it will give way to decay.

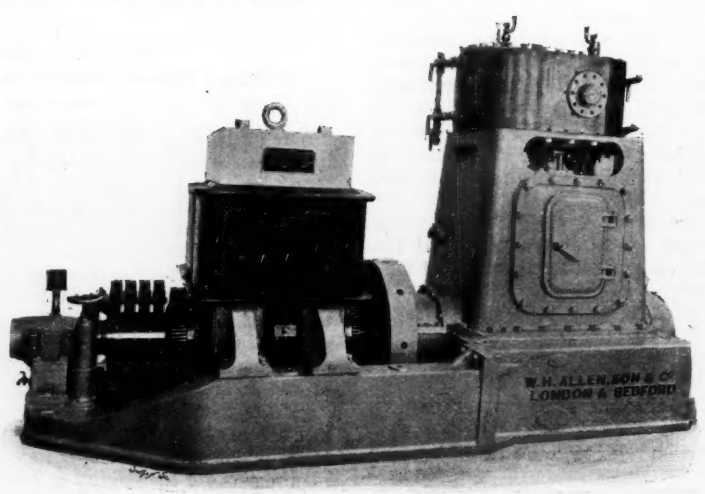
To what extent ought the tree to be stripped of its bark? And what is the most suitable time for this process and for the felling of the tree are questions that can only be decided by experiment. It will perhaps be found most suitable to fell the tree during the first winter.

If mountain firs or pine trees are used, and if they are treated in the same way as the old peasants treated their house timber, it may be possible to obtain telegraph poles, which Nature herself has prepared so well, that they will only require very little additional treatment to make them last for many a year.

COMBINED SHIP LIGHTING PLANT.

We illustrate herewith two high-speed double-acting engines and dynamos, which have lately been constructed by Messrs. W. H. Allen, Son & Co. One set of plant is specially adapted for use on shipboard, the other being for central station work. The latter plant is the larger, the dynamo having a capacity of 500 amperes at 135 volts, with a speed of 400 revs. per minute. The maximum rise of temperature after six hours run is but 45° Fah. The armature is of the drum type, and the field is shunt wound with a rheostat for the purpose of regulating the voltage. Worm gearing is provided for shifting the brushes. The cylinders of the engine are 7½ inches and 15 inches in diameter by 8 inches stroke, and give 120 I.H.P., with an initial pressure of 160 lbs. when exhausting into the atmosphere. The high speed is rendered possible by the ample supply of oil which is forced through all the bearings at a pressure of 20 lbs. per square inch by a valveless oil pump working in the crank-pit. Similar engines are also coupled to alternators for central station work, one of 300 H.P. having been recently supplied at the Bedford Electric Light Station. With a pressure at the stop valve of only 120 lbs. per square inch, and exhausting into the atmosphere, the steam consumption per E.H.P. hour for the 65 kilowatt engine and dynamo was 26 lbs.





The smaller engine and dynamo is one of eight which have been lately constructed by Messrs. Allen for torpedo boat destroyers now being built on behalf of the Admiralty. In order that they may be capable of maintaining long continuous runs at the high speed of 500 revs. per minute without attention, the engine is, as in the preceding case, supplied with forced lubrication. The cylinders are arranged in tandem and are 3 inches and 6½ inches in diameter by 4½ inches stroke. Each is cast separately, and is fitted with a piston valve. As lightness of weight is of very great importance, aluminium has been used for the bedplate and outer bearing castings, making a net reduction of 6 cwt. as compared with the similar design in cast iron. The total weight of the engine and dynamo together is but 22 cwt., the output being 8 kilowatts or 10¾ electrical horse-power. When supplied with steam at a pressure of 160 lbs. per square inch, and running at 500 revs. per minute, the engine gives 15 I.H.P., the exhaust being to the atmosphere. The consumption of steam per E.H.P. hour for the above output is 38 lbs. The dynamo to which it is coupled gives 100 amperes at the standard voltage of 80 as adopted for the Navy. The connections of the armature winding to the commutator are arranged to bring the diameter of commutation to the horizontal line where the brushes are more readily accessible.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Electric Interlocking the Block and Mechanical Signals on Railways. By F. T. Hollins, Member. Paper read January 28th, 1897.

So far as I am aware, there has not been a paper read before the Institution for a number of years (if at all), dealing with the general question of block signalling and electric interlocking on railways.

This fact, and the importance of the subject; the improvements in the systems in use; the various arrangements for special purposes; the constant extensions of the application of electricity for expediting, and more safely controlling the traffic on our railways, is, I trust, a sufficient apology for bringing the subject forward on the present occasion.

It is obviously impossible, within the limits of this paper, to give minute and detailed descriptions of *all* systems of block and interlocking apparatus, but, so far as I am in a position to do so, I will *briefly* describe those systems of electric interlocking in practical use on other railways, and deal more in detail with the system (Sykes's), of which, being responsible for its adoption, construction, and maintenance, on the Great Eastern Railway, I am naturally in a better position to speak with some authority.

I trust that those members who are more closely associated with other systems, will give the Institution the benefit of their better knowledge and experience, by adding such details, and other information during the discussion, as may seem to them to bring out the advantages, or otherwise, of such systems.

I take this opportunity of heartily thanking my colleagues (the railway telegraph engineers) who have been good enough to afford me so much information with regard to these systems.

A little prefatory explanation may be desirable for members unacquainted with railway work.

For the purpose of controlling the traffic passing over a railway, it is necessary to divide up the line into short sections, varying in length in proportion to the traffic, the point of division being indicated by the provision of a signal box, having fixed outdoor signals. The signals are usually a distant signal and a home signal, with, at busier places, a starting signal, and, at very busy posts, an advance starting signal, for each road; and for sidings, junctions, and cross-over roads there are additional signals for the protection of these connections. These are manipulated by the signalman, so as to indicate to the drivers of trains if they may pass the point where such signals are fixed. The distant signal is merely a caution signal to advise the driver (if it is at danger), that the next signal, that is, the home signal, (which is a stop signal), may be also at danger, and that he must be prepared to stop; but if the distant is "off," he knows that under ordinary circumstances the stop signal is also "off." The mechanical locking ensures this.

Prior to the invention of the telegraph (and, I am afraid, for some time afterwards), the running of trains was merely regulated by a time interval. Later on, a system of electric bells was established, to indicate when a train might be allowed to enter a section, and when it had passed through that section.

In 1840, an arrangement of electric signalling of trains was first used on the opening of the Blackwall line, between Minories and Blackwall; and at about the same time a needle block was made use of on the Midland Railway through Clay Cross Tunnel. In 1844 a slightly different arrangement was brought into use on what is now the Great Eastern Railway (each instrument showing all the sections, for the whole line) between Norwich and Yarmouth; and in 1853 a perhaps more efficient system of needle block and bell was introduced by Mr. Edwin Clark on the London and North Western Railway.

The term "electric block signalling" is generally applied to a combination of electrical apparatus, which, by means of an acoustic and visual signal, gives such indications to the signalman, as enables him, by a proper manipulation of his outdoor signals, to prevent two or more trains getting into one block section upon the same line of rails at the same time.

The block systems in general use may, practically, be divided into two separate groups—those operated by, and the indicators held in position by, a constant current on the line (the single needle semaphore, or disc instrument) to either indicate, in accordance with the polarity of the current, "Line clear" or "Train on line," and normally (by gravity) "Line blocked;" and those systems (principally Tyer's) the apparatus of which is operated to indicate "Line clear," or "Train on line," by momentary currents, and the indicators of which are held in that position by the residual magnetism remaining after the cessation of the current which actuates the needles and reverses the polarity of the magnets.

There are several variations of both systems; but for the constant current, three line wires (one for the up line, one for the down line, and one for the bells), are generally made use of; and for Tyer's apparatus only one wire is required for the up and down line, and the bell communication also.

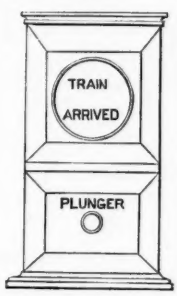
The term "electric interlocking" (that is, interlocking the outdoor signals with the indoor block signals), is generally applied to a combination of electrical and mechanical apparatus, which *compels* the signalman to work his outdoor signals absolutely in accordance with his electrical block signals (both of which are electrically under the control of the signalman at the box in advance), and with the most complete systems so controlling by means of a rail contact the signalman at the box in advance, that neither the block apparatus nor the outdoor signals at the rear box can be operated to admit a following train until the preceding train is absolutely clear of the section.

Next to the Sykes system there is no doubt Mr. Spagnoletti's has been the most largely adopted. It is in use throughout the Metropolitan Railway; at perhaps a dozen important places on the Great Western Railway; at the junctions of the Great Northern and Midland Railways with the Metropolitan Railway; and several other points.

Spagnoletti's Electric Interlocking.

The transmitting or accepting instrument is provided with a plunger, two movable discs, and one fixed disc, together with an electro-magnet. The outward appearance of the apparatus is shown in fig. 1; and fig. 2 is the lock indicator.

Fig. 1.



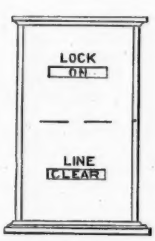


Fig. 2.

Fig. 3.

The three indicator discs in the transmitting instrument respectively indicate "Train arrived" (a fixed disc), "Line clear sent," and "Train on line coming." The lock-indicating instrument has two discs carried upon the needle of an ordinary single-needle coil, as shown in fig. 3.

The indications are "Lock on," and "Line blocked," given by gravity, and "Lock off," and "Line clear," by a current, and are made to appear before the two apertures in the screen, in accordance with the position of the lock. The coil giving this indication is merely in a local circuit of which the lock acts as a relay. Whilst the lever is in the "off" position, a train cannot be accepted; and at junctions of conflicting roads of any kind, it is arranged that, having plunged to accept a train from one road, it is impossible to plunge to accept one from the other, until the train accepted has arrived and the signal is put to danger. The operation is this: "A" has a train for "B," and gives the "Is line clear?" signal on the bell. "B" responds (if the line is clear), by plunging on his accepting instrument, fig. 1, and his plunger is locked, giving to himself the indication, mechanically (but held by the current electrically), "Line clear sent." This takes out the lock of the section signal at "A," and indicates "Lock off" and "Line clear." When the signal has been taken off, the train passes into section A B, and, after clearing the signal, it actuates a rail contact, which indicates on "A's" instrument "Train arrived," unlocks his plunger for the rear section, and shows "Train on line coming" at "B" by interrupting the current on the line, and causing the "Line clear sent" disc to rise from before it. On the train arriving at "B," and passing over his rail contact into section B C, the "Train arrived" disc is disclosed—the "Train on line coming" disc having been released, and moved by gravity from before it by the same current and coils that unlock the plunger to allow a following train to be accepted. The electric lock is really upon the trigger of the lever, and not upon the lever, or a tappet of the lever, itself. The lock therefore controls the trigger, and the trigger controls the lever.

The system described, I am told, is not quite the same as that on the Metropolitan, or the Great Western Railway, but the arrangement described is, as it is recommended by Mr. Spagnoletti, for lines to be fitted with entirely new apparatus. The arrangement at present in use has been adapted to the existing form of block.

If I might presume to suggest, I should say that the coils for giving the block indications "Line clear," and "Line blocked" ought to be in the line circuit, and quite independent of the indications of the "lock," for several reasons.

Langdon's Electric Interblocking.

On the Midland Railway, Mr. Langdon has in work, I believe, over some 12 or 14 block sections, an arrangement of electric interlocking which was devised by him for use in combination with the single-needle block apparatus, so that the system of block working should remain unaltered.

Instead of the usual pin, or locking trigger, to peg over the handle to "Line clear," or "Line blocked, a small pedal, on either

side of the handle, is provided. To give "Line clear," the pedal, to hold the handle over in the right direction, switches in an additional battery, sufficient to operate the lock of the controlling signal in the rear, as well as the needle of the block instrument—the two coils being in series. On the "Train entering section" signal being given, the pedal, pressed down to hold the handle to "Line clear," is released, and the opposite pedal depressed, to lock over the handle to give "Line blocked" to the rear. In pressing this pedal down, the handle, or commutator, is locked over into this position, and can only be released by the action of an electro-magnet, which is in circuit with a rail contact fixed a suitable distance ahead of the controlling signal for the section in advance. The transmitting instrument therefore remains locked up, giving the "Line blocked" indication, until the train actually arrives and passes over a Siemens mercury rail contact. The signal must be put to danger behind the train (when it is automatically relocked), or the circuit arrangements in the instrument remain such that "Line clear" cannot again be given.

The electric lock consists of a sliding bar or tappet fixed in a slot, and suitably attached to the tail-piece of the signal lever. A notch across the sliding bar and the slot serves to receive a small steel bolt (engaging in both bar and slot), carried by a light lever. At the opposite end of this is an armature to be operated by a non-induced electro-magnet, suitably wound so that the ordinary current of four cells used for the block indications alone will not operate it; the additional battery switched in by the "Line clear" pegging pedal being necessary.

EVANS'S ELECTRIC INTERLOCKING.

On the Manchester, Sheffield, and Lincolnshire Railway there is a modified system of electric interlocking on trial which is designed to allow of either "absolute" or "permissive" block working. The starting signals are duplicated (both locked), one for the "absolute" and the other for the "permissive," to indicate to the driver if he may proceed under the permission of "absolute or "permissive" block working. Either signal, as required, can be worked by the same lever.

Constant-current needle instruments are employed, and a switch is turned which indicates to the operator whether a train has been accepted from the rear on the "permissive" or "absolute" block system. This switch controls the working, and when it is in one position the "absolute" signal only is released; when in the reverse position, the "permissive" signal only is released.

The switch in the instrument at the box in advance being turned to either "permissive" or "absolute," and the handle being pegged to indicate "Line clear," a current is transmitted to the rear box which, by means of a relay in the line, and three pairs of electro-magnets acting as an electrical selector and lock, releases either one or other of the signals as required. The man in advance lowers his home signal; the train arrives, and is protected by that signal; and the back motion of the lever locks up the block instrument, and is itself locked until the starting signal has been lowered for the train to proceed, and is again put to danger. Instead of a rail contact, by which the train alone can free and clear the section in its rear, the back motion of the starting signal lever is the final motion permitting another train to be accepted up to that signal. Under ordinary arrangements, so long as the "Line clear" signal is appearing, the lock would stand released, but a special device is provided to break down the lock circuit immediately it is unlocked, and it is only joined up when "Line blocked" is given from the station in advance. This ensures the signal only being used once with the one "Line clear" current, and compels the sending of "Train on line"—an excellent arrangement simply effected.

On the Caledonian Railway a modified system of electric interlocking has been adopted over about 50 sections of their new city and suburban lines in connection with the ordinary Tyer's three-plunger block instrument, with the addition of a plunger lock, a polarised relay, an electric lock on the starting signal, a Sykes's signal reverser (see figs. 22, 23, and 24), and a rail contact.

The "Line clear" plunger can only be used once to free the section signal in the rear when it becomes electrically locked, and this lock can only be taken off when the train arrives and passes over the rail contact in the section in advance. The same rail contact that clears the "Line clear" plunger to accept another train from the rear box, also by means of the Sykes's signal reverser, puts the signal to danger behind the train as it enters the next section. This apparatus was designed, I understand, so as to allow of the old system of block working being strictly adhered to. The method of dealing with sidings, junctions, and cross-over roads would, I am sure, be interesting, and I invite Mr. Dunn, the company's telegraph engineer, to give us some information on this point.

TYER'S ELECTRIC INTERLOCKING.

Mr Tyer has completed a combination of block and electric interlocking which is (as might have been expected) of considerable merit. The outward appearance of the best form of his old block is retained, and there is every indication of all the different motions that could be desired, using a signal reverser to automatically put the signal to danger, and a rail contact to clear the rear section by unlocking the "Line clear" plunger. The lock is on the trigger of the signal lever, and is a very neat and simple arrangement. The signalman in advance may very effectually block back after accepting a train in case of an emergency, and even after the signal at the rear box is off; in fact, he may give "Line blocked" and put the signal to danger too.

BLAKEY AND O'DONNELL'S ELECTRIC INTERLOCKING.

On the Great Northern Railway, Blakey and O'Donnell's electric lock and block is on trial over, I believe, two sections near London. The apparatus, which is as under, seems to be mostly "Sykes's," applied to the single-needle block. There is a Sykes's signal reverser or replacer normally discharged, so that the rod does not engage with the arm until the current is received; a lever contact for closing the circuit to the reverser; a polarised relay in circuit, with the block instrument at the rear end of the section; a relay in connection with the block instrument at the advance end of the section; and Sykes's rail contacts or treadles.

Diagram fig. 4 shows the connections.

When the advance station, "B," pegs the block instrument to "Line clear," this actuates the block needle, 2, and the polarised relay, 3, at "A," and partially completes a local circuit through the signal reverser, 4, on the starting signal. The signalman at "A" in pulling the signal lever joins up the lever contact, 5. This completes the local circuit; the reverser is geared, and the signal arm, 6, lowered. It will be seen that without this current the lever, if pulled, would not lower the signal. The train passing into the section actuates the rail contact or treadle, 7, and the relay, 8, attached to the block instrument at "B," disconnects the commutator of the block instrument, and joins up the battery, 9, which brings the needles of both block instruments to "Train on line." This reverses the tongue of the polarised relay, 3, at "A," and the local circuit being disconnected the signal reverser puts the starting signal to danger behind the train. This state of things remains until the train reaches the second rail contact or treadle, 10, at "B," which, momentarily disconnecting the circuit of the relay at "B," restores the block needles to zero, and the apparatus is ready for accepting another train from "A."

The Great Northern Railway Company have also, at King's Cross tunnel, an interesting arrangement of electric interlocking, utilising the rails as conductors, in such a manner as to ensure that any engine with its train occupying the line shall be fully protected by

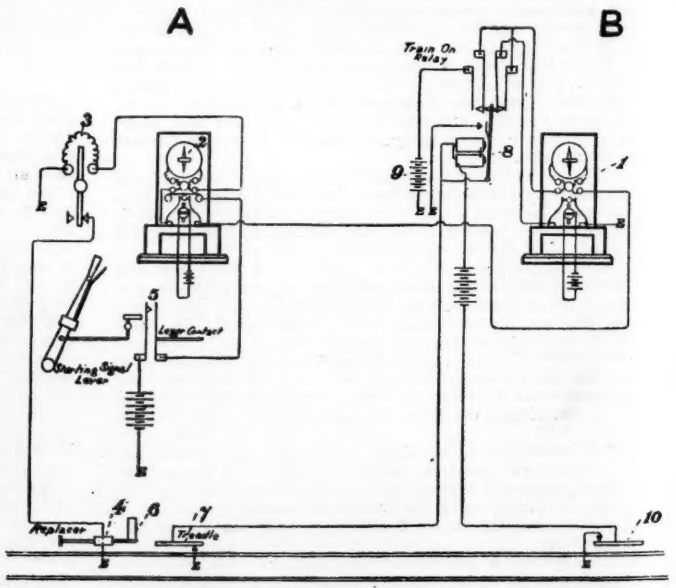


FIG. 4.

the signals, and such signals shall not be capable of being lowered until the line is clear. (There is a somewhat similar arrangement to this, minus the signal reverser, on the London, Chatham, and Dover Railway, at St. Paul's.)

(To be continued.)

Physical Society.

ORDINARY MEETING, JANUARY 22nd, 1897.

Prof. AYRTON, vice-president, in the chair.

Mr. CROFT gave an exhibition of some simple apparatus.

The exhibition included an ingenious form of clip to fit on an upright retort stand. A nicol used for projecting the rings and brushes in crystals, with which it is sufficient to use the ordinary condenser of the lantern, the source of light having been moved further away from the lens than is usual. Some photographs, showing caustics, conical refraction and defraction, a stand for magnets, &c., when demonstrating the attraction and repulsion of poles, a stand for the suspension of objects for experiments on diamagnetism, a holder for X-ray tubes, consisting of a spiral of wire fitting round the exhaustion tube of the bulb, an X-ray photograph taken by means

of a Wimshurst machine, a model of Michelson's interferenic experiment, an arrangement to show subjective colours in which a double lantern is arranged to give two partly-overlaping discs, a sheet of green glass is placed before one lantern and the light of the other decreased till the illumination of the two discs is the same. The overlap then appears white, while the remainder of the uncoloured disc appears red.

Prof. Silvanus Thompson said he was surprised that "patent plate" was sufficiently good for Michelson's experiment. Had the author tried illuminating the discs in his subjective effect experiment for a very short interval so that the eye should not have time to wander from one disc to the other?

Mr. Griffith said that if you looked through a tube at one disc at a time, one appeared green and the other white.

The Chairman said the point seemed to be, could you fatigue the eye simultaneously, or must it be successive.

Prof. Silvanus Thompson said two common 1-inch microscope objectives were very suitable for projecting rings and brushes.

Mr. E. C. Baly read a paper on the "Passage of Electricity through Gases."

In this paper, which is of a purely controversial nature, the author brings forward as arguments that electrical conduction in gases is not of an electrolytic nature, the following:—(1) That the sign of the charge on the supposed gaseous iron is variable. (2) The initial resistance of a gas. (3) The invalidity of Ohm's law. (4) The permanence of the supposed gaseous electrolyte. (5) That every mixture of gases must equally be an electrolyte. (6) That the potential gradient in a vacuum tube when the current is passing has been shown to be very uneven. It is very steep in the cathode glow, and is by no means a regular decline between the electrodes.

Prof. Armstrong said it was difficult to know from what point of view the author had treated the question. The first part of the paper consisted almost entirely of a criticism of Prof. J. J. Thomson's theory and experiments. Prof. Thomson, however, is not the only observer who has dealt with this subject. The author's arguments seemed vitiated by the fact that he has looked upon the subject from one very narrow standpoint only, viz., the ionic hypothesis, and Lord Kelvin, for instance, does not believe in the truth of the ionic hypothesis; even in the case of liquids Prof. Thomson has shown that the phenomena depend on the dryness of the gas, so that the conduction cannot depend on the gaseous molecule alone. In the case of conduction induced by a neighbouring discharge, this might be due to the expulsion of condensed vapour from the walls of the vessel. It would appear that in the dry state gases are not electrolytes.

Mr. Enright said he thought it was not correct to say no work was done in electrolysis.

Prof. Silvanus Thompson said that the pursuit of the analogy between the conductivity in gases and liquids was apt to lead one too far. Thus, if you compare the conduction in a mixture of H and Cl with electrolysis your analogy will be a false one unless you import into the term electrolysis the idea of chemical separation as taking place in the solution. If a current separated a mixture of powdered zinc and sulphur it could not be called a case of electrolysis.

Prof. Armstrong said an experiment of Prof. Dewar's was very instructive. He had shown that if you cool the surface of a Crookes tube the discharge stops. It was quite inconceivable that at these low pressures the gas became liquefied, so that this experiment seemed to show that conductivity depends on the presence of a vaporous electrolyte.

Mr. Enright asked if Prof. Armstrong knew how the presence of an electrolyte assisted conduction.

In a communication Prof. J. J. Thomson said that in the decomposition of steam by a spark, the fact that in the tube as a *whole* the amount of steam decomposed is greater than the amount of gases liberated in a voltameter in series was no objection to the conductivity being electrolytic. The only condition imposed by the laws of electrolysis was that the excess of H or O at one terminal, and of O or H at the other should correspond to the amount of electricity passing through the tube. Thus, suppose in a water voltameter a number of metal partitions are fixed so that the current has to pass across these plates. Then at each plate, H will be given off on one side, and O on the other, and by making the partitions sufficiently numerous the total quantity of gases given off for the passage of a given current may be made as large as we please. The excess at the partitions would not be affected at all by these. In the experiments made by Mr. Rutherford and himself (Prof. Thomson), they did not observe any polarisation when the conductivity was produced by Röntgen rays. With reference to Mr. Baly's objections to the electrolytic theory: (1). There is no reason to think that under conditions other than in solution the atom of hydrogen may not have a negative charge. (2). The electrolytic theory leads us to expect that it would require a finite electromotive force to send a discharge through a gas. Before such a discharge can take place the molecules must be split up, and this requires an electric field of finite strength. (3). In the case of a gas the electric field has to ionise the molecules, so that an increase in the strength of the field will not only (as in the case of a liquid electrolyte) increase the speed of the ions, but it will also increase their number, and thus the current will increase faster than the electromotive force. (4). The ion once used can again combine, and since the ionisation is done by the electric field it can be again split up and used again. If, however, the ionisation has been done by external sources, as, for example, by Röntgen rays, then we find that the conductivity decreases as the current passes. (5). There seems to be no reason on the electrolytic theory why in a mixture of HCl and Cl some of the current should not go through the chlorine. (6). A variable potential gradient would be produced if the ions moved with different velocities. Mr. Baly's process in the positive column appears to be the same as on the electrolytic theory minus the atomic charges.

In a communication, Prof. Schuster said: Mr. Baly criticises what he calls the electrolytic theory, but directs his arguments against a form of the theory which is, as far as the writer knows, advocated by no one. Mr. Baly appears not to have read the original papers in which the fundamental points of the theory upheld by J. J. Thomson and the writer (Prof. Schuster) are explained. If he had done so he could not have given as an objection to the theory that the conductivity of a gas increases with the E.M.F. The essential difference between a liquid and a gas is, that in the liquid the number of ions is fixed by the chemical constitution of the liquid, while in a gas dissociation, has first of all to be produced by the current itself, and hence the number of ions depends on the current. In the paper referred to by Mr. Baly in which the fact that when a spark is passed through a gas the gas ceases to insulate for some distance round the spark is described, the explanation that this was due to a difficulty of passage of the electricity from the electrode into the gas was especially disclaimed. The explanation given being substantially the same as that now given by Mr. Baly. Mr. Baly asks what becomes of the ions that are set free. The answer, of course, is that they recombine. The view that stratifications are due to compound molecules and do not probably occur in pure gases is not new. With reference to the author's statement that "measurements made by Wheatstone and J. J. Thomson, prove that the electricity travels along the positive column from the anode to the cathode, and that its velocity is about half that of light." Prof. Thomson's results show that the breakdown of the insulating power of air takes place in the manner described, but this does not show anything as to what happens when the discharge has reached the steady state. Mr. Baly is quite wrong in the excess charges he assigns to different parts of the vacuum tube. Experiments on the excess charges can count for nothing unless they are done with continuous currents. Mr. Baly is further wrong in stating that the fall of potential is rapid in the glow. On the contrary it is very small in the glow, being very rapid in the dark space between the glow and the cathode. Mr. Baly adopts Prof. Thomson's view as to the formation of molecular chains, but in a form very difficult to accept. The whole foundation of Mr. Baly's theory is upset by his wrong assumptions as to the excess charges in different parts of the tube.

The Author in his reply said that on some points he had been misunderstood. He thought that the increase in conductivity could not be due to vapour driven off from the sides, for ultraviolet light also produced such an increase. If Röntgen rays produce ionisation then there ought to be a reduction of density of the gas.

A FEW PRACTICAL NOTES ON ALTERNATE CURRENT SWITCH-GEAR.*

By L. ANDREWS.

During recent years several papers have been read before different societies on alternating current working, dealing with the generation, transformation, distribution and regulation of the current. To-night I wish to draw your special attention to what I think may justly be termed the heart of the work, namely, the switchboard, or, as it is now more correctly termed, the switch-gear. This is the centre from which all other important parts of the work are controlled, and a slight mistake here often causes a complete interruption of the whole supply. That these total interruptions do sometimes occur, even in modern stations, must, I am afraid, still be admitted. But from what I have been able to learn about them, it appears to me they might nearly all have been prevented if more attention had been paid to the design of the switch-gear.

Is there not a tendency to rely too much upon experienced attendants? Of course I do not wish to under-rate the advantage of a skilled switchboard attendant; but I think the switch-gear should be so designed, that an average man can control it if necessary. The most careful man may sometimes make a mistake. Besides, he is always liable to break down, and a small station cannot always afford to keep an equally efficient spare.

We often see inserted in advertisements for alternating current switch-gear attendants a clause stating that applicants *must* be able to synchronise. This need of such a special qualification for alternate current work has often appeared to me to be a weak point about this system of electricity supply. If a man knows that his character as an efficient switchboard attendant depends upon his always synchronising at exactly the right moment, he is far more likely to make the lights jump than he would be if he felt that it was not possible for him to make a mistake. The effect it has upon the men appears to be much the same as I am told an average person experiences in looking over a precipice. If a rail makes it impossible for him to fall, he does not feel any tendency to do so. But if he knows that his life depends upon his keeping a steady head, he is far more likely to lose it. Mr. Faraday Proctor, of Bristol, appears to have recognised this in 1894, for in the Electrical Review of March 9th in that year, he explained that at Bristol, instead of switching directly on to the bus bars through the main switches, they first switched on to the circuit through a very light fuse. If the machines were badly out of phase, the fuse prevented a big rush of current passing.

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* Paper read before the Northern Society of Electrical Engineers, January 25th, 1897.

This appeared to us at Hastings to be a move in the right direction, and we determined to imitate it. But we thought a magnetic cut-out would be better than a fuse, because it would be quicker in its action and would be more easily re-set. During the past two years we have always used a safety device of this description, and although it is now only on very rare occasions that it cuts out, we are satisfied that the very fact of its being there enables the men to synchronise very much better than they would do without it.

A diagrammatic sketch of this arrangement is shown in fig. 1. The current from the generator, A, passes through the solenoid, B, to the outer bus bar, through the lamps, D, to the inner bus bar, and back to the generator through the switch contacts, F_1, F_2. To switch this generator on to the bus bars the handle is brought down to its lowest position, thus setting the weight, W, behind the catch, and closing the contacts, F_2. It will be noticed that the circuit is still interrupted at F_1. The handle is then returned to a nearly vertical position, thus leaving the weight, W, free to fall when it is released by the catch. As soon as the synchroniser voltmeter shows the machine to be approximately in parallel, the handle is pushed home, thus finally connecting the generator on to the omnibus bars. If it

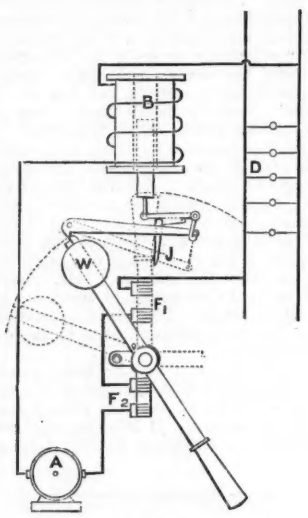

FIG. 1.

is at all out of phase, the current from the bus bars rushes into the generator *viâ* the solenoid, B, thus lifting the core and releasing the catch, and weight, W. The latter falls freely through an angle of about 45°, increasing in momentum on its journey. It then strikes the arm connecting the two contacts, F_2, and carries this round through an angle of about 90°, so interrupting the circuit at this point. (The contacts, F_2, are immersed in water.) The series of operations is then repeated, and an attempt made to catch the next phase. To switch machines out of parallel, the handle is pulled out of the contacts, F_1, but before the circuit is interrupted at this point, the pin in the handle engages in the catch, J, thus releasing the weight, and breaking the circuit at the contacts, F_2.

We have noticed in using this arrangement that a long, steady phase, is not necessarily the best for synchronising. If we let the machines get over the steady phase, and let the needle begin to pulsate quickly again, they always go into parallel without the slightest flicker. If we wish to get machines in quickly we don't wait for a steady phase, but have shots at any appearance of a correct phase. I have no hesitation in letting anyone who has never seen machines parallel before synchronise with this arrangement.

Nearly all the complete interruptions that have occurred during recent years have been originated by the failure of some portion of a set of plant working in parallel with others. I suppose we shall never get running machinery so perfect as to be able to depend upon its never breaking down, but we can arrange it so that the failure of one set shall not affect others working with it.

In continuous current stations, the return current or zero cut-out serves for this purpose, and it is probably this device which has enabled these stations to gain the reputation of being more reliable than their alternating contemporaries. Zero cut-outs have been suggested for alternating current work, but immediately the alternator fails it short circuits a very much higher difference of potential than a continuous current generator would do, and it also has comparatively very little self-induction, consequently, although the current momentarily falls to zero, it instantly rushes up to a very much higher current in an opposite direction, and, therefore, it would not allow a zero cut-out time to be affected.

I believe Mr. Raworth, of the Brush Company, was the first engineer to design a cut-out that would discriminate between a generating and motoring alternating current. The ingenious way in which Mr. Raworth persuaded the generating current to avoid the fuse and travel round by the shunt, and the motoring current to select the fused conductor, is probably familiar to you all.

It occurred to me about two years ago that although it was impossible with alternating currents (that naturally reversed their direction a hundred times a second) to employ a magnetic cut-out that released, when its poles were reversed, relatively to a constant polarity; yet it might be possible to construct a somewhat similar device having its poles excited from two distinct sources, and connected up so that it would release only in the event of the direction of the current from one source being reversed *relatively to the other*.

For this purpose I wound a number of turns of comparatively fine wire on the series coils of the magnetic cut-out described just now. This winding was connected as a shunt across any transformer excited off the main omnibus bars, and was arranged so that the direction of the current in the shunt winding was opposite to that in the series so long as the dynamo to which it was connected was generating current.

In fig. 2, the two alternators, A, B, are working in parallel, and supplying the lamps, C. At a given moment the direction of the current through the whole system will be represented by the arrow heads shown full, provided both machines are generating current. It will be noticed that the current through the shunt winding of the magnetic cut-out, D, is opposite in direction to the current through the series winding, consequently the field produced by the one is wiped out by the field of the other.

If one of the machines, say A, is suddenly disabled, it becomes a short circuit on the bus bars, and the current from the other machine rushes into it in the direction of the dotted arrow heads. Of course, the fuse of this machine ought to immediately blow and cut it free; but if, as often happens, only one of the other machines is running at the time, or possibly two machines of a smaller output; then since these have to provide all the current being used by the lamps, in addition to that required to blow the faulty machines' fuse, they will generally succeed in blowing their own fuses first, and so completely interrupting the general supply.

It will be obvious that a motoring current from any one machine will not affect the direction of the current in other portions of the system; consequently, the direction of the current in the series windlng of the compound wound solenoid will now be reversed relatively to the current in the shunt, and the two fields will now help each other to release the catch, thus opening the circuit and disconnecting the faulty machine. It may appear at first sight that the shunt current will not balance the series current for any load, that is to say, if the windings are proportioned so that a series current of 15 amperes just balances the effect of the shunt winding when the machine is generating, and just releases when it is motoring, then a generating current of 45 amperes would appear to so predominate over the shunt as to be of itself sufficient to release the catch. This would be so with a continuous current arrangement, but with alternating currents the shunt increases almost in direct proportion to the series, because, when the shunt coil only is acting on the core its self-induction will be so great as to allow only a small current to

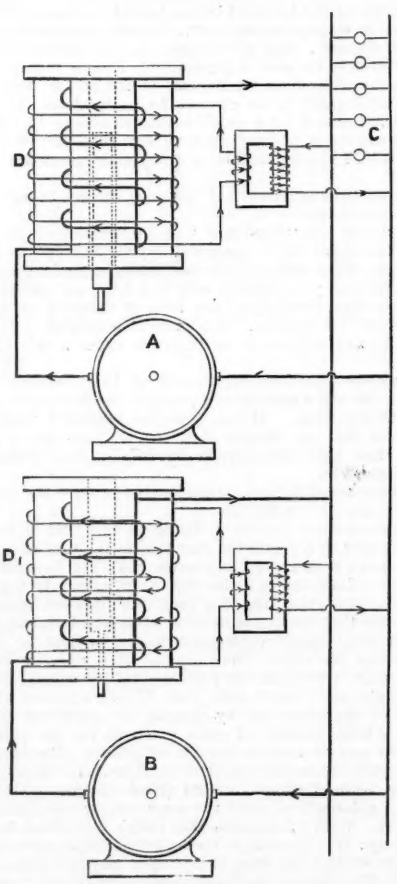

FIG. 2.

pass. But since the current in the series winding is in an opposite direction to the current in the shunt, it decreases the latter's self-induction by mutual induction as it increases, and so allows a proportionately larger current to pass. This increase of the current is so marked, that I have found it possible to use an incandescent lamp in series with the shunt to indicate the current in the series winding.

Last year we had our station at Hastings equipped with cut-outs made upon this principle, and they always worked very well. They were adjusted to cut out with a motoring current of 15 amperes, but would not release with a generating current of not less than 100 amperes. We thought this would be quite sufficient a range to work between. But one day the horrible thought occurred to us that if we got a short circuit on our mains the balancing theory would not work, because the series current would be very large, whereas the shunt current, being short-circuited, would fall to practically nothing. Consequently, the series current, having nothing to balance it, would have it all its own way, and immediately release the catch. The result would be most disastrous, as all the working machines in the station would promptly be cut out of action. I was bound to admit that my remedy for motoring currents would be likely to cause more breakdowns than it would prevent. For some weeks I almost despaired of getting over this difficulty. Several combinations of springs, relays, &c., were tried, some of which worked and some did not. They were, however, all too complicated to be a permanent success, and I will not detain you with a description of them, but will simply explain to you the final satisfactory result of several months' experimenting with these various devices. This is shown at D1, fig. 2. You will see we still use a compound wound solenoid connected up as before, the only difference being that the shunt winding is wound half in one direction, and half in the other, and the normal position of the core is exactly in the centre of the coil. If we again let the full arrow heads represent the direction of the current through all parts of the system at a particular moment when both machines are generating current, then it will be seen that the direction of the current in the shunt winding of the solenoid, D, is opposite to that in the series winding in the top half of the solenoid, but in the bottom half both of the currents are flowing in the same direction. The result is that the two windings neutralise each other at the top, but assist each other to produce a magnetic field at the bottom, and the tendency is to hold the core down, thus making it impossible for the cut-out to release. Should the generator become disabled, the direction of the shunt remains the same, but the series is now reversed, as shown by the dotted arrow heads. The shunt winding now opposes the series in the bottom half of the coil, and helps it in the top, thus producing a magnetic field above the centre of the solenoid, causing the core to spring up and release the catch supporting the weight, and so disconnecting the faulty machines from the general supply. It is not necessary to provide a separate transformer for each switch; in fact, at Hastings, we excite all the shunts off the station lighting circuit. The shunt current by itself will not have any effect upon the core, because the two windings being wound in opposite directions will neutralise each other. Again, the series winding alone will tend to hold the core in the centre of the coil, but as that is its normal position it will not be moved.

(To be concluded.)

ELECTRIC LIGHT AND COAST DEFENCE.

At the Garrison Classroom, Devonport, on the 26th ult., Capt. M. A. Boyd, R.E., of the Submarine Mining Establishment, Plymouth, gave a lecture, entitled "The Application of the Electric Light to Coast Defence." As to the use of the light, the lecturer said three important factors had to be taken into account, viz., the position of the projector, of the observer, and of the object. The efficiency or otherwise of the illumination depended on the relative distances between those points, and for effective illumination the projector must be suitably placed in relation to those who were to work by its light, whether at guns or observing instruments. Small vessels could be distinguished in a concentrated beam at distances from the projector of from 3,000 to 4,000 yards, and in a 16-degree dispersed beam at from 1,500 to 2,000 yards. The great power of a concentrated beam, and the intense brilliancy with which it lighted objects at a long distance, was of great value, but its area of illumination being small, it required to be kept very carefully on the target. This was difficult unless it was controlled by an observer in a good position. By multiplying the search lights the result would be confusion, and it was therefore generally considered desirable to restrict the employment of search lights, and use dispersed beams, although their range was short. The typical defence of a large military port would be a scheme of concentrated search lights in an advanced position, 16-degree dispersed beams behind, in connection with the mine fields, with possibly 30-degree beams commanding any narrow passages or boom obstructions. The principal ports had been provided with apparatus for the last 16 years, and periodical practice was carried out. In 1889 some important trials were carried out at the Isle of Wight, Malta, Bermuda, and Jamaica. In those operations concentrated beams only were used, and search lights were freely employed. The attacking vessels represented battleships, and heavy guns were fired by the defence. The deductions drawn in the reports laid stress on the serious effect of smoke, the importance of placing the projectors on low sites, and of providing effective control of the search lights. In 1890 experiments were again carried out at the Isle of Wight, at Sheerness, and in the Thames. At the Isle of Wight operations eight lights were in use, all but one being concentrated beams. One dispersed beam was used, but it was not entirely successful. The results obtained seemed to show that a satisfactory state of efficiency had been achieved as regarded the apparatus for the production of the light, but a general feeling prevailed that some guiding principles should be laid down as regarded the organisation of coast defence generally, in order to meet the recognised changes in the probable form of attack. In 1892 some instructive trials took place at the Needles, six lights being used—three fixed and three search. Included in the six were four 30-degree dispersed beams. The Navy took part, and all attacking vessels steamed at high speed. The trials exploded some too sanguine estimates which had been formed of the power of the lights. It was made clear that the Needles passage could be so illuminated as to make it practically impossible for vessels to pass without being seen, when everything was in readiness. Trials were carried out in Plymouth Sound in August, 1895, and December, 1896, with a view to providing the best dispositions of the lights to meet local conditions. In the 1895 experiments two lights were placed in Cawsand Bay, two at Picklecombe, and one on a lighter near the Breakwater Fort. The Cawsand Bay outer light was used as a search light. It was found that 30-degree beams were very inadequate to illuminate vessels on the most probable line of attack. The lights were at first placed on the top of Picklecombe, but subsequently were moved to a much lower position. The trials carried out in December last were much more complete. Nine beams were employed, and lenses of 16-degree dispersion were substituted for those of 30-degree in all the wider channels, and, in addition, the lights were more powerful. The usefulness of the trials was greatly enhanced by the fact that attacking vessels were represented by six torpedo-boat destroyers, which entered the harbour at 18 or 20 knots. Observers were posted at all the important points round the Sound, and time records were taken both of the moments the destroyers passed fixed periods, and also of the periods the vessels could be seen by the observers on shore. The results showed clearly that under the conditions of the trials, the weather being rough and sometimes misty, the vessels could not enter without being seen. On the other hand, it appeared that the average time a vessel remained under fire was only from a minute to a minute and a half, and that the average time between the first alarm and the arrival of the vessel at the inner defences might be from 12 to 15 minutes. If the trials had not solved all the difficulties and problems connected with the electric light in coast defence, they were at least much further advanced than a short time ago, and it was to be hoped they would be able to give a good account of themselves should occasion arise.

In the discussion which followed, Col. Walker said some of the points touched upon by Capt. Boyd were of great importance to the Royal Artillery. They were all agreed upon the value of search lights. At the experiments in 1892 at the Needles, whenever a search light was used, it detected the approach of the enemy a long distance off, and all the defences were able to be on the alert.

Col. Bell spoke of the importance of having the lights well protected, and of the co-operation of the Royal Artillery and Royal Engineers. The use of the electric light in coast defence was still in its infancy, and they could not organise experiments too often.

Major Haines commented on the few opportunities which Royal Artillery officers had of controlling search lights.

Lieut.-Gen. Sir Forrestier-Walker asked whether there was any lesson to be learnt from what foreign countries were doing in the matter of coast defence.

Capt. Boyd said foreigners were going ahead, and according to a magazine article, the Italians appeared to have search lights almost everywhere.

Capt. Mills pointed out that the opinion was expressed in connection with the China-Japanese war that, but for the lights of the defence, the attack would have utterly failed.

The officers afterwards witnessed some search light experiments by way of a practical demonstration of the use of the projector.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

1,271. "Electric locomotive railroad and self-signalling system." H. McAlpine. Dated January 18th.

1,279. "Improvements in and relating to accumulators or storage batteries." W. Rowbotham and C. Levetus. Dated January 18th.

1,311. "Electric envelopes and wrappers and the like." H. M. Field. Dated January 18th.

1,319. "Improvements in writing telegraphs." O. Imbay. (Leon O. McPherson, United States.) Dated January 18th.

1,337. "Improvements in electrical machines." A. Verley. Dated January 18th.

1,344. "Electric signalling apparatus applicable for indicating the rising of dough." J. Best. Dated January 18th.

1,361. "Improvements in electric current switches." A. J. Wheatley. Dated January 19th.

1,369. "Improvements in and relating to accumulators or storage batteries." W. Rowbotham. Dated January 19th.

1,381. "Improvements in fittings for electric installations, and for bell pulls and the like." A. E. Goddum. Dated January 19th.

1,430. "Improvements in and connected with electrical storage batteries." E. J. Wade. Dated January 19th.

1,434. "Improvements in or relating to electric railways." J. F. McLaughlin. Dated January 19th. (*Complete.*)

1,435. "Improvements in or relating to electric railways." J. F. McLaughlin. Dated January 19th. (*Complete.*)

1,467. "Improvements in telephone switches." E. E. Ries. Dated January 19th. [Date applied for under Patents, &c., Act, 1883, Sec. 103, June 26th, 1896, being date of application in United States.] (*Complete.*)

1,521. "Improvements in adjustable liquid resistances for starting and regulating electric motors" J. H. Holmes. Dated January 20th.

1,535. "Improvements in the electric precipitation of gold and silver from their cyanide solutions. A. James. Dated January 20th. (*Complete.*)

1,557. "An improved appliance for use in connection with telephone receivers." C. A. J. Jellie. Dated January 20th.

1,572. "Improvements in electrolytes for the disposition of zinc and for use in secondary batteries." H. Leitner. Dated January 20th.

1,581. "Improvements in or relating to electric lampholders, wall sockets, and the like." H. B. Swift. Dated January 20th.

1,583. "Improvements in the manufacture and production of filaments for incandescent electric lamps." J. W. Swan. Dated January 20th.

1,591. "An improvement in incandescent electric lamps." H. C. Glover and J. M. Moffat. Dated January 20th. (*Complete.*)

1,595. "Improvements in electrical accumulators." T. Hamilton. Dated January 20th.

1,610. "An electrical dissolver and slide charging apparatus for optical lanterns." H. S. Pyne and A. Elsee. Dated January 21st.

1,627. "Certain improvements in apparatus for the electro-deposition of metals." A. E. Cook. Dated January 21st.

1,631. "Improvements in apparatus for automatically causing a flow of water or other fluid or making or breaking an electric circuit automatically by the fusion of a suitable joint or connection." H. Beech. Dated January 21st.

1,648. "Improvements in electric switches and in apparatus for connecting electric circuits." J. D. F. Andrews. Dated January 21st.

1,651. "Improvements in multiple contact telephone transmitters and the battery circuit connections relating thereto." C. Adams-Randell. Dated January 21st.

1,657. "An improvement in the electro-deposition of metals and alloys." G. A. Webb and W. A. Thoms. Dated January 21st. (*Complete.*)

1,660. "Improvements in alternating current motors." W. Langdon-Davies. Dated January 21st.

1,714. "Improvements in and relating to accumulators or storage batteries." W. Rowbotham. Dated January 22nd.

1,734. "A system of electrical signalling or communication between the occupant or occupants of a cab, carriage, or other road vehicle propelled by horse or other power, and the driver or drivers thereof, and apparatus therefor." W. P. Maycock. Dated January 22nd.

1,753. "Improvements in rheostats with a liquid medium." W. R. Lambert. Dated January 22nd.

1,754. "Improvements in electric arc lamps." W. R. Lambert. Dated January 22nd.

1,755. "A new or improved arm rest in connection with telephones." M. Byng and F. G. Bell. Dated January 22nd.

1,756. "Improvements in double contact switches especially adapted to telephones." M. Byng and F. G. Bell. Dated January 22nd.

1,771. "Improvements in electrically driven sheep shearing or hair clipping machines." W. Baines and W. Norris. Dated January 22nd.

1,789. "Improvements in electric cables." W. S. Smith and W. P. Granville. Dated January 22nd.

1,800. "An improvement in or connected with electric clock movements to record the time by electricity." W. H. Stockall. Dated January 23rd.

1,827. "Improvements in and connected with electric motor cars." W. E. Heys. (J. J. Heilmann, France.) Dated January 23rd. (*Complete.*)

1,849. "Improvements in electric railways on the conduit system." N. H. Balfour and E. W. Smith. Dated January 23rd.

1,882. "Improvements in and connected with electric switches." W. K. Partington. Dated January 23rd.

1,887. "Improvements in or connected with incandescent electric lamps." The British Incandescent Electric Lamp Co., Ltd., and H. E. Moul. Dated January 23rd.

ELECTRICAL PATENTS OF 1883 EXPIRING IN FEBRUARY, 1897.

We are informed by Messrs. W. P. Thompson & Co. that about 70 applications for electrical patents were filed in the month of February, 1883. Only two of the patents granted on these applications have been maintained to run their full length of term, and being of considerable interest, we give short abstracts of them below:—

623. "Improvements in apparatus for measuring and regulating currents of electricity." Philip Cardew. Dated February 5th, 1883. The current is measured by passing it through certain conductors, and noting the expansion that takes place when the conductors become heated, the expansion being registered by the movement of a pointer round a prepared scale. The instrument may also be adapted as a regulator. A metallic conducting wire is enclosed in a tube of similar material, at the bottom of which is a box, in which the pointer of the instrument is pivoted. The conducting wire is attached to the pointer near its pivot, and the pointer is adjusted to zero by means of a screw at the top of tube. Weights or springs may be attached to stretch the conducting wire. Upon passing the current the wire is expanded, and the pointer falls through a certain angle shown on the scale. Several conducting wires, or a thin strip of metal may be employed, or several turns of one long wire may be used for passing the wire over pulleys fixed to the top of tube and bottom of the box. Instead of a metal tube a metal rod may be used, the wire being protected by wooden or other casing. The motion of the pointer may be multiplied by levers, or the expanding wire may be made to coil into a screw thread cut upon an axis which carries an index moving over a dial. Resistance coils may be combined with the instrument, and the conducting wires may be protected from oxidation by coating with paint or oxide to prevent the fusion of the conductor; the pointer may be arranged to short circuit the current, or a piece of wire of smaller section may be included in the circuit. The apparatus may be used to regulate the current furnished by a dynamo. In such case a piece of carbon, or other conductor, attached to the pointer closes a shunt circuit on the magnetising coils when the potential reaches a previously determined point. Or the pointer may be caused to increase or decrease the number of lamps in the circuit according as the potential increases or decreases. 1 claim.

973. "Improvements in dynamo-electric machines." John Hopkinson. Dated February 22nd, 1883. The object of this invention is to obtain greater effect without increase of size and weight of the machine. The cross-sectional area of the field magnets is increased, and their length diminished. The field magnets may be of the "Edison" type, or of a ring form, the cross-sectional area being increased, and the length diminished, in each case. The mass and magnetic cross-section of the armature may also be increased. 1 claim.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

4,434. "Improvements in, or connected with, moulds for use in the manufacture of secondary battery plates or supports." F. King. Dated February 27th, 1896. Relates to a means of removing the castings of secondary battery plates from the moulds, so as not to buckle or twist the casting. In moulds constructed of two parts, pins pass through one part of the mould into holes in the other part, so that when the metal is poured into the mould, it fills the space in the mould and surrounds the pins; the pins also serve to remove the casting from the mould. 3 claims.

8,141. "Switch apparatus for electromotors and automatic resistance regulators." Siemens Bros. & Co., Ltd. (Siemens & Halske, Berlin.) Dated April 17th, 1896. Relates to a switch for electromotors, and consists in the combination of a switch actuated by a rotatable axis or axes, and a variable resistance. The axis of the resistance regulator is so arranged relatively to the switch axis, that at each movement of the latter the resistance regulator is operated by a force set free by such movement, so as automatically to include resistance in the circuit before the switch breaks contact. By this means sparking at the switch and commutator is avoided when changing two or more electro-motors from parallel to series connections, or the reverse, or when changing the connections of separate winding sections of a single motor. 1 claim.

24,367. "Improvements in conduits for electrical conductors." E. Levens. Dated October 31st, 1896. Relates to a conduit for electrical conductors, constructed by inserting a tubular lining of soft, pliable, and resilient insulating material within a metallic armour, and then by external pressure is drawn or pressed down closely upon the tubular lining, thus making a close and uniform joint. 1 claim.